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PROSPECTS FOR RUSSIAN MILITARY R&D

SHARON LEITER

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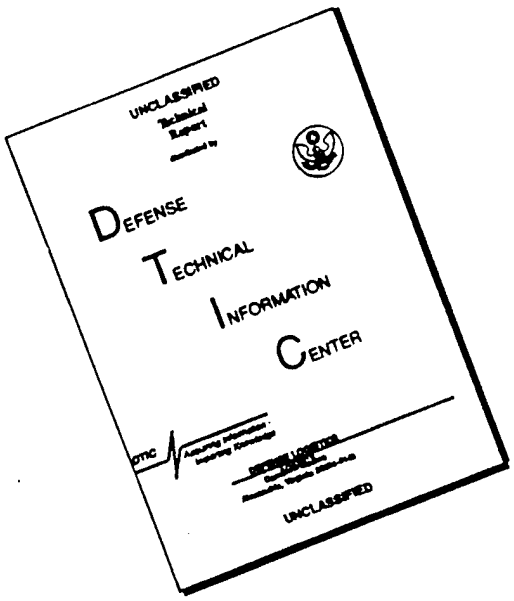

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SHARON LEITER

PREPARED FOR THE UNITED STATES ARMY

RAND

PREFACE

This study examines the Russian military's options for achieving weapons modernization and new weapons development through either a revitalized state military research and development (R&D) sector or a robust civil scientific and technical (S&T) sector. It considers the likelihood that neither of these sectors will prove adequate to the military's needs in the near term, forcing Russia to turn to the West or elsewhere for military-technical assistance. By investigating trends in the Russian scientific community as a whole, including science funding, higher education, the brain drain, and the evolution of scientific organizations, it assesses long-term prospects for Russian military R&D.

This report should be of interest to members of the U.S. intelligence and policy communities and others concerned with Russia's role both as a military power and as a supplier of weaponry on the world market. It should be of particular relevance to the U.S. Army as it seeks to gauge the potential for future Russian military technology and to determine its own priorities, within the context of ongoing military reduction. This analysis considers information available through September 1995.

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SUMMARY

This study presents an analysis of the short- to mid-term future of Russian military R&D by considering both the current state and the prospects of the traditional providers thatcontinue into the present from the Soviet period, as well as possible new entrants into the field. The report examines the prospects for the revitalization of the once-powerful Russian military R&D sector; assesses evidence for the growth of a robust civil S&T sector, capable of supporting military aims; and evaluates the newest Russian S&T policy statements within the context of the human and material resources available for their implementation.

REVIVING THE STATE MILITARY R&D SECTOR

Both in the former Soviet Union (FSU) and in today's Russian Federation (RF), federal budget funding, in the form of state orders for defense-related goods and services, has been the dominant mechanism for funding military R&D. The crisis of military-directed research is thus a direct reflection of the sharp, inexorable decline of the defense order, which began in 1989 when Gorbachev first set in motion the wheels of military downsizing. The 1994/95 winter's budget debates raised expectations that 1995 would be the year of change. More than the deepening crisis in the defense industry, the spectacle of poorly equipped forces in Chechnya motivated government promises that funding would be raised. But the 1995 defense budget, approved by the Duma in March, is considerably lower in real terms (when inflation is factored in) than 1994's. Since appropriations for military procurement and R&D contain amounts for repayment of

the 1994 debt for unpaid defense orders, they are even lower than they at first appear. Combined spending on arms purchases and military R&D is down to 3.2 percent of the GNP, compared to 4.5 percent in 1994.

Moreover, as in 1994, many of the appropriated funds are not reaching their destinations. In the current budgetary process, the Ministry of Defense controls actual allocation of funds within the state defense budget. Although R&D has strong advocates within the Ministry of Defense, the material needs of an army at war will doubtless be given first consideration, making it likely that only a small percentage of the modest budgetary funds allocated for R&D will actually be distributed in 1995.

The impact of this continued "starvation diet" will be felt most keenly by those sectors already in the greatest distress: branch science and the science cities. Alternative, nonbudget funding mechanisms offer some relief, but amount to only a minuscule portion of total science funding. While advocates of defense R&D continue to emit a steady stream of resolutions aimed at strengthening this sector, lack of both material resources and unified political will frustrates their efforts. With the government's continued failure to allocate 1995 defense funds causing heightened social unrest, the military-industrial complex (VPK) held a series of crisis conferences in the spring of 1995 and resolved to form its own political party.

CREATING A ROBUST CIVIL S&T SECTOR

The 1995 civil science budget has fared no better. The Russian Academy of Sciences (RAN) received a sum amounting, in real terms, to only 60–70 percent of the previous year's allotment. In addition, the government's promise to "strictly" implement the 1995 budget and repay its 1994 debt has not been fulfilled. During the first six months of 1995, RAN was expected to receive less than 60 percent of funds appropriated to it for that period. This latest crisis has led to predictions of the disintegration of institutes and laboratories and massive firings. The fact that RAN workers were on strike in June 1995, just as they were in June 1994, underscores the sad consistency of the budgetary process: allocation of inadequate funds for S&T, little more than half of which is actually handed out.

At the same time, new funding sources have provided substantial infusions of hope for scientists and appear to be slowly transforming the infrastructure of basic science. The International Science Foundation (ISF), founded in 1992 by American financier and philanthropist George Soros, has contributed more than $130 million to basic science in the FSU and Baltic countries, thereby enabling many research institutes to stay open. By supporting top researchers, the ISF has helped assure that they will remain in science, thus keeping the inevitable contraction of Russian science from becoming a completely random process. Having spent its original monies, the ISF is engaging in matching-grant programs with the federal government; grants will be allocated according to ISF procedure, using Western methods of peer review that have demonstrated to a skeptical Russian scientific community how grants may be awarded meritoriously. As part of its program to promote new approaches to funding and managing research, the ISF is offering other foreign donors the use of its successful infrastructure for distributing help to science. The extent to which this offer is accepted will be a crucial factor in the continuing flow of foreign grant monies.

Meanwhile, the Russian Foundation for Basic Research (RFFI), the most likely candidate for becoming "the Russian National Science Foundation," is carrying forward the ISF model of science funding and playing a key role in establishing joint projects with foreign donors. The new grant competitions are having their impact on traditional bureaucratic structures. RAN has retained its prestige, but as its institutes become more self-supporting, it plays a diminished role in institute decisionmaking. As research groups within higher educational institutes (VUZy) take high honors in the competition, the prestige of VUZ science is increasing. Although the migration of basic science from the Academy to the universities has not occurred, institutional barriers are weakening as Academy and VUZ research groups increasingly engage in joint projects.

As they explore alternative forms of funding and management, groups from all three traditional sectors of Russian science—Academy, VUZ, and branch—are participating in the growth of a commercial R&D sector. There has been a steady increase in the number of small, mostly private S&T firms since 1991; statistics place their current number as anywhere from 40,000 to 90,000. The wide discrepancies in evaluations of the economic health of these firms

may be due to the absence of comprehensive research as well as to the diversity of the small firms, some of which are self-generating entities, while others were formed as spinoffs from large institutes. However they evolve, the small S&T firms are playing a vital role in the growth of a commercial R&D sector by serving as laboratories for the development of a style of management closer to that of Western entrepreneurs. They are participating in the creation of technoparks, the formation of technical joint ventures, and the marketing of Russian R&D abroad.

The greatest obstacle faced by all these innovative organizational forms is the inadequacy of both domestic and foreign investment. It is the rare Russian investor who turns a willing ear to the entreaties of the S&T sector, though foreign investors are somewhat more attracted to this arena. However, prospective foreign investors (mostly American) are encountering xenophobic attitudes, which work against the passage of measures to stimulate and protect their investments. Institute directors speak resentfully of having no choice but to sell their research services to foreigners, complaining that the Russian government does not support experimental research. The question arises as to whether a commercial R&D sector, nurtured by foreign investment and partnerships, would be responsive to the needs of a Russian military that could not afford to pay handsomely for its services. At present, however, with foreign investment in S&T still small, the Russian government still retains the option to enlist these vital scientific resources for national security ends.

DEVELOPING ADVANCED R&D: ENDS VERSUS MEANS

In response to the crisis, the spring of 1995 brought several new S&T policy initiatives, from every sector of the defense and civilian science establishment. A high-level council for scientific and technical policy was established as a consultative body and charged with developing proposals on critical issues in S&T policy. At the same time, a formal government decree, "On State Support for the Development of Science and Scientific and Technical Developments," was created primarily by RAN and the Ministry of Science and set forth a daunting list of tasks and goals, including allocation of all necessary funding for the preservation of Russian science, total reform of the national R&D infrastructure, and ratification of top-priority avenues of

S&T development. In this latter task, it appears already to have been preempted by GKOOP (the State Committee for the Defense Industry), which has put forth a "National Technology Base" program containing an extensive list of critical technologies. The emergence of these two major plans demonstrates that the Russian government is aware of the extent of its science crisis and has well-developed notions of what directions must be pursued to overcome its "technology lag."

Whether it has a realistic strategy for obtaining its ends is another matter. Given the steady deterioration of science's material base and the continued exodus of scientists from their professions, Russia faces the danger that its existing S&T resources will be lost faster than new ones can be created. The brain drain continues, with 1995 reports continuing to affirm that the youngest and most talented scientists are abandoning the research sector. Between 1990 and 1993, the number of scientists plunged by 1.2 million or by almost one-third. Seventy to eighty percent of Russian mathematicians have gone abroad, and the theoretical physicists are not far behind them. This represents a loss of both quantity and quality, since only the best are offered positions abroad.

The same outflux of the most talented is occurring in the higher technical schools and universities. Enrollment has been dropping steadily for a number of years; although the numbers increased in the past two years, this cannot yet be considered indicative of a long-range trend. Eighty percent of students at Russia's VUZy have no intention of working in their chosen field, and 74 percent do not participate in VUZ scientific work. The VUZy are having trouble finding employment for their graduates, due partly to the perceived decline in the need for specialized knowledge, and this doubtless contributes to the defection.

Meanwhile, the positive transformation in scientific working conditions that would be needed to staunch these processes is not in sight. While some predict that there will be a "missing generation" of Russian scientists, others foresee a period in which young scientists will be underrepresented, but not altogether absent. What would remain is a diminished but by no means permanently disabled S&T community.

CONCLUSIONS

The prospects for Russian military R&D are inextricably bound up with the evolution of the technology sector as a whole—military, civil, dual-use—which is itself hostage to an increasingly conflictual and strained sociopolitical situation. Laws, programs, and policy initiatives abound, but bear little relation to what is actually done. With perilous levels of social distress making primary claims on the budget, there is no reason to believe that government S&T funding will increase substantially any time soon. New competitive funding methods may gradually improve the way that grants are distributed and thereby ensure that as the science community shrinks, many of the fittest will survive. That a good many institutes and design bureaus will *not* survive is becoming increasingly apparent.

To the extent that the RF government perceives Western capital and technical cooperation as the Russian scientific entrepreneur's best hopes, it is motivated to pass legislation that stimulates and protects foreign investment. But this strategy increasingly conflicts with a self-defeating desire to close the West out, fueled by nationalistic resentment of Russia's underdog position and a distinctly Cold War–style paranoia.

This study concludes with three broad-brush political-economic projections. In the "worst-case scenario," xenophobic elements triumph in the next election, scaring off Western investment even before they have a chance to close it off. In the "best-case scenario," a more moderate leadership could take steps to reform the S&T infrastructure and set up more realistically financed programs for developing selected key technologies. Finally, in the projection that seems most likely, a "stasis scenario," new elections will lead to more of the same: a bitterly divided Duma reflective of the deep political, social, economic, and philosophical schisms afflicting the Russian populace. Without strong, directed leadership, socioeconomic distress will persist and science will remain a "top national priority" in name alone. Within a year or two, there will be a serious degradation of basic experimental scientific capability, as well-furnished laboratories become rarer and rarer. This loss will have a negative impact on basic theoretical, applied, and defense science. The continuing shrinkage of the Russian S&T base will accelerate, while the segment that survives and prospers will, to a great extent, owe its well-being to

an international S&T community with which it is increasingly integrated. Until Russia succeeds in creating its brand of market economy and achieves widespread economic prosperity, a process that could take a generation, its military will probably find itself far more dependent than it would like upon foreign S&T resources for the modernization of its weaponry.

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ABBREVIATIONS

EBRD	European Bank for Reconstruction and Development
FIG	Financial-industrial group (*finansovaya-promyshlennaya gruppa);* also abbreviated FPG
FSK	Federal Counterintelligence Service
FSU	Former Soviet Union
GKOOP	State Committee for the Defense Industry (*Gosudarstvenniy komitet oboronnoy promyshlennosti*)
GOSKOMSTAT	State Committee for Statistics (*Gosudarstvenniy komitet po statistiki*)
GOSKOMVUZ	State Committee for Higher Educational Institutions (*Gosudarstvenniy komitet vysshykh uchebnykh zavedeniy*)
ISF	International Science Foundation (a division of the Soros Foundation)
KB	Design bureau (*konstruktorskoye byuro*)
MGU	Moscow State University (*Moskovskiy gosudarstvennyy universitet*)
MinSci or Minnauki	Russian Ministry of Science (*Ministerstvo nauki*)

MNTK	Interbranch scientific-technical complex (*Mezhotraslevoy nauchno-tekhnicheskiy komplex)*
MOD	Ministry of Defense (*Ministerstvo oborony*)
MP	Small enterprise (*maloye predpriyatiye*)
NII	Scientific research institute (*nauchno-issledovatel'skiy institut)*
NSF	National Science Foundation
RAN	Russian Academy of Sciences (*Rossiyskaya Akademiya Nauk*)
R&D	Research and development
RDT&E	Research, development, testing, and evaluation
RF	Russian Federation
RFFI	Russian Foundation for Basic Research (*Russkiy fund fundamental'nogo issledovaniya)*
S&T	Science and technology
TsAGI	Central Aerohydrodynamic Institute in Zhukovskiy
VPK	Military-industrial complex (*voyenno-promyshlennyy kompleks*)
VUZ	Higher educational institution (pl. VUZy) (*vysshee uchebnoye zavedeniye*)

Chapter One

INTRODUCTION

Revelations emerging from the war in Chechnya on the shoddy and even dysfunctional state of Russian weaponry and military equipment may have shocked the casual foreign observer, but cannot have come as much of a surprise for those who have followed the downward fortunes of the Soviet/Russian defense industry in recent years. Since serious downsizing of the military got underway in 1989, draconian cuts in the defense budget have undermined every aspect of weapons acquisition, from research, development, testing, and evaluation (RDT&E) to production. With the reduction of final-assembly weapons plants and attrition of highly skilled technical cadres, both the quantity and quality of weaponry have suffered. Developing a well-informed picture of the nature and extent of this degeneration—one that avoids the pitfalls of either exaggeration or underestimation—is essential to the U.S. armed forces as they formulate their own weapons development policies.

Of the vast reporting emerging from the Chechnya conflict, two items suffice to suggest the dimensions of the Russian weapons crisis:

- On January 18, 1995, INTERFAX reported that representatives of military scientific research institutes (NIIs) and weapons design bureaus (KBs) had been dispatched to the war zone to determine why their products had "performed so poorly." According to one designer, certain military KBs had received urgent orders to develop better protection for tanks operating in urban combat zones. It had been more than a decade, reported this same de-

signer (who preferred to remain anonymous), since protection measures for T-72 and T-80 tanks had been upgraded.[1]

- In the sixth month of the war, reports appeared of complaints from Russian helicopter gunship pilots who have dubbed themselves "kamikazes" because they are forced to fly 15- to 20-year-old helicopters, which lack defenses against missile attacks, with only half a load of ammunition.[2]

What this juxtaposition of reports underscores is the apparent intractability of the situation: After more than five months of warfare, things had not improved and may even have deteriorated.[3] It is against this protracted failure to sustain previously achieved levels of military readiness, to maintain and upgrade equipment, and to produce essential supplies of ammunition that one must view the magnitude of the problem of future Russian weapons modernization and development.

A comparison with the recent Clinton administration decision to trade military modernization for readiness begins to reveal some of the complexity and severity of the Russians' dilemma.[4] Under present conditions, they can opt for neither readiness nor modernization. Funding shortages may be at the root of each superpower's abstemiousness with respect to military R&D and procurement. But for Russia, there are other, equally serious inadequacies. The United States is gambling that high-tech upgrades can extend the useful lives of existing military hardware; Russia doesn't have those upgrades available. The United States assumes that its military-industrial base will still be there when needed; Russia can make no such assumption. Fresh evidence of the disintegration of its once-massive defense industrial complex appears with sobering regularity in the Russian press: reports of idle and bankrupt factories, decaying capi-

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[1]From the on-line news service Open Media Research Institute Daily Digest, January 23, 1995.

[2]*Segodnya,* June 2, 1995, reported by Open Media Research Institute Daily Digest, June 5, 1995.

[3]With the eyes of the world upon them and a powerful ambition to market their arms on the international market, a lack of motivation among Russian military planners or defense industrialists can hardly have been the problem.

[4]*The Washington Post,* May 19, 1995.

tal stocks, unpaid and demoralized workers, and defection of highly trained scientific cadres. If U.S. military downsizing is taking place within a (relatively) stable social context, Russia's is both the victim of and contributor to the constantly shifting socio-economic-political sands.

For these reasons, in assessing the present and future prospects for Russian military R&D, it will be necessary to go beyond an analysis of the all-important question of how Russian science will be funded. Structural changes within the scientific community, the emergence of innovative financial-industrial-scientific entities, the fate of higher education, the migration of scientific cadres, and the vicissitudes of East-West cooperative arrangements—all will significantly affect technological development. Nor is it possible, in attempting to forecast the likely course of events, to ignore the larger questions of who rules Russia and whether its economic health continues to deteriorate or is on the mend.

Accordingly, this study is divided into three major sections. Chapter Two will examine the prospects for the revitalization of the once-powerful military R&D sector. Chapter Three will assess the evidence for the emergence of a robust civil scientific-technical (S&T) sector, capable of supporting military aims. Chapter Four will evaluate the newest statements of Russian S&T policy within the context of available resources for implementing them. A brief concluding chapter, which speculates on the impact of macroeconomic and political trends, will argue that increasing participation in the general movement toward globalization of arms development represents Russia's best hope for maintaining and advancing the technological level of its weaponry.

Chapter Two

REVIVING THE STATE MILITARY R&D SECTOR

THE MORIBUND STATE DEFENSE ORDER

Both in the former Soviet Union (FSU) and in today's Russian Federation (RF), federal budget funding, in the form of the state defense order, has been the dominant mechanism by which military R&D has been financed,[1] not only in the 500–700 R&D institutes of the military-industrial complex,[2] but in numerous "civil" research institutes, both in such industries as machine production and nuclear and chemical technologies, and in the Academy of Sciences.[3] On the most basic level, then, the crisis of military-directed research in Russia is a direct reflection of the sharp, inexorable decline of the defense order that began in 1989 when Mikhail Gorbachev set in mo-

[1]For an incisive analysis of Soviet science, including military R&D, just prior to the breakup of the Union, see Harley Balzer, *Soviet Science on the Edge of Reform,* Boulder: Westview Press, 1989.

[2]As Keith Bush noted in "Aspects of Military Conversion in Russia," *RFE/RL Research Report,* Vol. 3, No. 14, April 8, 1994, p. 1, authoritative statistics on the scale of the Soviet defense complex have yet to be published and pronouncements tend to be inconsistent and sometimes skewed for political purposes. Thus, Viktor Glukhikh, then chairman of the Russian Committee for the Defense Industries, spoke of 660 military scientific institutions (*Segodnya,* December 25, 1993), while a recent Russian television program (*Planerka,* on January 26, 1995, as reported in FBIS-SOV-95-019, January 30, 1995, p. 21) said there were "more than 500 such institutions."

[3]Boris Saltykov, Russia's Minister of Science, Higher Education, and Technical Policy, said that two-thirds to three-quarters of the science establishment was oriented toward defense. Georgetown University Conference on Science and Technology and Industry in the Former Soviet Union, April 27–28, 1992. *Radikal,* No. 12, April 1992, p. 9, reported that more than 50 percent of all appropriations for science were spent on defense science, which employed up to 40 percent of the country's scientific personnel and engineers.

tion the wheels of military downsizing. In 1991, the military R&D budget was cut by 15 to 20 percent. The most severe cuts were made in 1992, when the defense order as a whole was reduced by more than two-thirds, while the R&D component was cut by 25 to 40 percent of the already reduced 1991 budget. Defense budgets for 1993 and 1994 continued this downward trend.

The budget debates of winter 1995 gave rise to expectations that 1995 would be the year of change. More than the deepening crisis in the defense industry and the continued strident complaints of defense industrialists, it was the spectacle of poorly equipped forces in Chechnya and the need to maintain the support and loyalty of the military that motivated promises, from the highest level, that help was on the way. At a meeting of chief designers and heads of military enterprises, President Boris Yeltsin announced the Kremlin's decision to take the military-industrial complex (VPK) off its "survival diet" and give it sizable orders.[4] With the Ministry of Defense announcing its intention to increase financing of scientific research and devote primary attention to designing new weapons technologies, the Duma supported proposals to shift money from other areas of the budget into science and military R&D.[5] At the same time, however, skeptics declared that nothing would change, except for the worse. During subsequent budget debates, the deputy chairman of the Budget Committee, A. Pochinok, expressed doubts that the transfer of increased allocations to science would occur, citing the difficulty of wresting funds from such items as government administration.[6] In an emotionally charged interview,[7] Alexander Piskunov, deputy chairman of the State Duma Defense Committee and chairman of the Duma Commission for Defense Spending, declared

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[4]Moscow NTV, February 7, 1995, reported in FBIS-SOV-95-026, February 8, 1995. The terms "R&D" and "S&T" are both used liberally throughout this report. S&T (science and technology) is the broader term, encompassing the spectrum of scientific activities, from basic research to applied to testing and evaluation. R&D (research and development) refers to applied research, directed toward specific product development. Throughout, I have attempted to use these terms discriminately.

[5]*The Washington Post,* January 24, 1995.

[6]*Finansoviye izvestiya,* March 22, 1995.

[7]"Will the Lessons of the Chechen Tragedy Be Taken Into Account When the 1995 Defense Budget Is Adopted? Or Will the Policy of Financially Ruining the Armed Forces Prevail Once More?" *Krasnaya zvezda,* January 25, 1995, pp. 1–3.

that "the asphyxiation of defense science in Russia is being successfully completed today." Piskunov predicted that "real defense appropriations in 1995 will be half what they were in 1994," even before inflation is factored in.[8]

In the event, the doubters were confirmed. In the draft budget approved by the Duma in March, the allocation for defense spending as a whole, 48,577 trillion rubles ($10.2 billion), was the biggest single expenditure item.[9] Although this represents an apparent increase over the 1994 ratified allotment of 40,600 trillion rubles, when inflation is factored in, in real terms the 1995 defense budget is considerably lower than 1994's.

Moreover, any comparison with the 1994 budget must take into account the discrepancy between what was legally allotted and what was paid out. According to at least one account, *actual* 1994 disbursements for military R&D amounted to only about two-thirds of the ratified amount (see Table 1).

Table 1

The Russian Federation Finance Ministry Debt in Financing the Defense Ministry in 1994 in Relation to the Sum Ratified by Law: The Military's View

	Billion Rubles Disbursed	Percentage of Appropriated Amount
Upkeep of the army and navy	5,628.6	26.0
Payment on armaments, military equipment, and property	3,013.5	35.8
Capital construction and major overhaul	2,558.0	53.3
Research and development costs	751.5	30.9
Total	11,951.6	32.1

SOURCE: Lt. Col. Ivan Ivanyuk, "Army Still Has Not Received 12 Trillion Rubles for 1994. What Is It Going to Live on This Year?" *Krasnaya zvezda,* February 8, 1995, pp. 1, 3.

[8]Data obtained from on-site interviews carried out by RAND analysts Andrew J. Aldrin and Adam N. Stulberg in late 1994 indicate that Piskunov's Duma Defense Committee holds hearings, but can only amend figures within the aggregate state budget.

[9]Open Media Research Institute Daily Digest, March 16, 1995.

These figures, it is essential to note, should be viewed with skepticism. Appearing as they do in a highly partisan military publication, they are as likely as not to be skewed in a direction favorable to the military's claims. Indeed, much of the statistical data emerging from Russia today is contradictory and less than reliable, a situation due not only to political bias but to technical and methodological difficulties.[10] Therefore, without attempting to arbitrate the discrepancy between Finance Minister Vladimir Panskov's assertion that the state owes the Ministry of Defense "only" 2–3 trillion rubles compared to the much higher figure quoted in the *Krasnaya zvezda* article, I will note only that the 1995 federal budget allotments contain within them amounts for repayment of the 1994 debt and are, therefore, considerably less than they at first appear. Table 2 shows the 1995 allocations for procurement and military R&D. These allocations were promptly condemned by such prominent defense industry advocates as Viktor Glukhikh, the chairman of the State Committee for the Defense Industry (GKOOP), who pointed out that combined spending on arms purchases and military R&D have been reduced to 3.2 percent of the GNP, compared to 4.5 percent in 1994.[11]

Whatever their insufficiency, preliminary reports indicate that the allotted funds are not reaching their destinations. On May 25, Finance Minister Panskov reported that the 1995 budget as a whole has been undermined by misspending. "Expenditures have exceeded limits during the first few months of the year," he said, blaming improper use of state funds, embezzlement, and tax evasion, all of which has led to the loss of hundreds of billions of rubles.[12] First

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[10]For an insightful analysis of the Russian statistics problem, see "Statistics: The Government's Eyes and Ears or Its Blinders?" by Valentina Vedesova, *Rossiyskiye vesti,* May 17, 1995, p. 2. Vedesova notes: "We should acknowledge that the proportion of obvious falsehoods in statistics has risen sharply. The reasons are obvious: the outdated, creaking mechanism of our computing department was programmed in accordance with the demands of the centralized planning of the age of socialism. It is unable to evaluate commodity markets, does not deal with financial flows, and has not mastered contemporary data processing technologies."

[11]INTERFAX, April 18, 1995.

[12]Open Media Research Institute Daily Digest, May 26, 1995. Other explanations for budget shortages have been offered by Deputy Prime Minister Oleg Soskovets, who told *Nezavisimaya gazeta* on May 19 that "we are in trouble" on the budget because of rising expenses of the Chechen war (from Monitor, the on-line news service of the Jamestown Foundation, May 22, 1995) and by the Duma Budget Committee, which noted that revenues from privatization and import and export tariffs were lower than

Table 2

1995 Allocations for Procurement and Military R&D

	Allocation in Rubles
Purchases of arms and military equipment	10.275 trillion[a]
Of which, repayment of debt for 1994	1.333 trillion
Research and development	4.936 trillion
Of which, repayment of debt for 1994	666.700 billion[b]

[a]The 1994 procurement allotment was 8 trillion rubles. Open Media Research Institute Daily Digest, May 26, 1995.

[b]*Rossiyskaya gazeta,* April 7, 1995. Russian Federation Federal Law No. 39-FL, signed by President Boris Yeltsin and dated March 31, 1995: "On the Federal Budget for 1995. Adopted by the State Duma March 15, 1995."

deputy Defense Minister Andrey Kokoshin complained that less than half the funds planned for defense projects had been received from January to May, citing a shortage of cash which resulted in delayed wage payments and slower production of military hardware.[13] As of May 8, defense plants had yet to receive state orders, according to Gennadiy Voronin, deputy chairman of GKOOP.[14] He reported that the government owes defense workers 1.75 trillion rubles; workers have been without pay for 2 to 4 months. Worse still, production in the defense sector dropped by nearly 30 percent in the first quarter of 1995, as compared with the same period in 1994.[15]

While I am not aware of comparable published figures on the fate of the military R&D allotment,[16] the above accounts leave little room for optimism. In the current budgetary process, the Ministry of Defense controls actual allocation of funds within the state defense budget.

planned and that government spending was underfinanced by 18 percent. Open Media Research Institute Daily Digest, May 23, 1995.

[13]Open Media Research Institute Daily Digest, June 2, 1995.

[14]INTERFAX, May 8, 1995, reported in FBIS-SOV-95-089, May 9, 1995.

[15]Military production in comparable prices fell by 30.1 percent in April 1995, compared with April 1994, in which production was down 24 percent since the beginning of the year. *Krasnaya zvezda,* May 27, 1995, p. 3.

[16]On August 27, defense ministry officials told Moscow radio that more than a third of the money allocated for R&D and arms acquisition was never disbursed. Monitor news service, August 29, 1995.

Thus, until the Duma's Defense Committee establishes legal protection for the defense line in the budget,[17] the Ministry of Defense has the option of refunneling "R&D money" to manpower, procurement, maintenance, and construction. Although R&D has strong advocates such as Kokoshin within the Ministry of Defense, the material needs of the army, compounded by the exigencies of an expensive war whose aftermath will continue to make heavy demands on the budget, make it likely that only a small percentage of the modest budgetary funds allotted for R&D will cross the thresholds of defense research institutes in 1995.

The impact of this continued "starvation diet" will be felt most keenly by those sectors already in the greatest distress: branch science—the hundreds of research institutes and design bureaus which, in the FSU, were subordinate to the 7–10 defense industrial ministries as well as to the twenty-odd "civilian" industrial ministries—and those uniquely Soviet configurations of defense-oriented branch and Academy institutes, known as the science cities *(naukograd)*.

THE CRISIS IN BRANCH SCIENCE

Russian science planners seem to agree that branch or "sectoral science"—consisting of 747 scientific organizations and employing 999,500 workers or 76 percent of the scientific work force—is in a desperate, if not already critical state.[18] But a divide occurs between organizations (such as the Ministry of Science and the Russian Academy of Sciences) that believe it is vital for "the preservation of

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[17]RAND analysts Andrew J. Aldrin and Adam N. Stulberg report that Duma Defense Committee members are strongly invested in protecting military R&D allocations, believing that R&D, not procurement, will enable qualitative downsizing of the arsenal while ensuring crisis stability and long-term military effectiveness. The Duma, however, is constitutionally constrained from overseeing implementation of the approved budget.

[18]Oleg Lezin, "Who's In Charge of Branch Science?" *Poisk*, No. 51, December 24–30, 1994, p. 1. Russian Academy of Sciences (RAN) vice president Evgeniy Velikhov stated, "Branch science is in a worse position than fundamental science. RAN succeeded in preserving itself and we have those to represent us in the government. Branch science does not.... There is no structure to administer and plan its development."

Russia's S&T potential in general"[19] for the state to bolster this sector and those (such as the Ministry of Economics) that believe a substantial number of these organizations—the ones that can't find paying customers to support them—should be allowed to die a natural death.[20]

At last December's Duma hearings on government measures to support branch science and the technical potential of industry, the Deputy Minister of Science, Andrey Fonotov, described a diminished and highly demoralized sector: Between 1990 and 1993, cadres were reduced by 33 percent. The state of the material-technical base has seriously declined, he claimed, citing the figures for the machine-building industry: capital investment in the NIIs of this complex in 1994 plummeted to (in comparable prices) 1.4 percent of the 1991 level; expenditures for equipment, instruments, and computers fell to 2.4 percent of the 1991 level.[21] Science-intensive, high-technology industries are in a state of depression, with production levels severely reduced; Fonotov cited an 88.9 percent decline in the output of numerical control machine tools and a 95.8 percent decline in the production of personal computers. The innovative activity of enterprises, which was never very high even in Soviet times, was said to be at a near standstill.

Although these precise statistics cannot be verified, the reality of a serious crisis in the electronics industry has been widely documented.[22] Whether this situation should be viewed as a catastrophe or—given the superior quality of foreign counterparts—evidence of a

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[19]Defense Minister Boris Saltykov, quoted in Andrew Bagrov, "The Budget Process: Sectoral Science Remains a Hostage of the Budget," *Kommersant-Daily,* December 21, 1994, p. 2.

[20]Ibid.

[21]Lezin, op. cit.

[22]The Russian press has been filled with articles documenting the crisis in the electronics industry. See, for example, Alexander Yegorov, "The Electronics Industry: There Is Hope for Survival," *Krasnaya zvezda,* February 18, 1995, p. 6; "Crisis in Electronics Industry Affecting Defense Orders," ITAR-TASS, March 14, 1995, reported in FBIS-SOV-95-050, March 15, 1995; Olga Koroleva, "Will We Break Through to the Computer Age?" *Rossiyskaya gazeta,* January 25, 1995, p. 4; Yuriy Dokuchayev, "Defend Those Who Defend Us," *Inzhenernaya gazeta,* No. 32, March 1995, pp. 1–2; and V. Sal'nikov, "Defending a Branch from the Market," interview of Stepan Sulashkin, *Inzhenernaya gazeta,* No. 34, April 1995, pp. 1–2.

system beginning to right itself is open to question. Fonotov, who clearly subscribes to the former interpretation, cites several causes for the crisis:

- the forms of the branch organizations themselves, which are unsuited for market conditions;
- the lack of market infrastructure in science itself;
- the virtual absence of nongovernmental sources—risk financing and credit innovation funds—for financing science; and
- the lack of consumer demand for new production technology "in a country which is undergoing a process of deindustrialization"[23] and where industry, therefore, has no need of science.

With the volume of industry-financed science reduced severalfold, it has fallen to the government to fund 90–95 percent of all kinds of R&D. (In the majority of developed countries, Fonotov observes, half of all R&D is financed by the state, half by the private sector.)[24] Yet budget funding has shrunk to less than half of what the scientists themselves consider a survival minimum. Participants at the Duma hearing requested that the 5 trillion-plus rubles allotted in an early budget draft be raised to 13 trillion. When the final draft budget was passed in March, only 6 trillion was allocated for "Basic Research and Promotion of S&T Progress," with less than 2 trillion rubles of this overall sum going to basic science and more than 4 trillion designated for "Developments of Promising Technologies and Priority Avenues of S&T Progress."[25] It is not clear whether this rubric stands for the remnants of the "federal S&T target programs," begun in 1992 and numbering more than 200 by the end of 1994.[26] Most of these programs are defunct, while the ones that remain and will be funded are oriented toward R&D on projects very near to completion, such as the purchase of aircraft for the state licensing company. Science

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[23]Bagrov, op. cit.

[24]Ultimately, the growth of private Russian investment in domestic R&D will require a virtual revolution in a number of macroeconomic conditions, which will be discussed below, in connection with the growth of a civil R&D sector.

[25]*Rossiyskaya gazeta,* op. cit., 1995 Federal Budget, Item 6.

[26]Appendix A lists the federal S&T programs for 1994.

Minister Saltykov has condemned such an approach as "undermining the foundation for development in the middle term."[27]

What are the probable consequences of such limited funding? According to RAN's Velikhov, they will be dire:

> If [in 1995] science is financed the way the draft law on the budget lays out, branch science will not survive. A whole series of centers will cease to exist, and this will affect not only Russia's scientific potential in the 21st century. We're talking about the present. If TsAGI [the Central Aerohydrodynamic Institute in Zhukovskiy] is destroyed, we will simply be incapable of certifying airplanes.[28]

State Science Centers

The government's primary response to branch science's distress, and the centerpiece of the Ministry of Science's policy in 1994–1995, is the creation of a substantial number of federally funded "state science centers" on the basis of existing R&D organizations. Of the 57 state science centers already in existence by the end of 1994, the majority were based on branch institutes.[29] As established by law, they are to be governed by two basic principles: federal financing and state ownership. For the chosen institutes, the latter condition is scarcely a hardship, the former a much-coveted lifeline. Thus, for example, the once "holy of holies of the country's air defenses," the Almaz Central Design Bureau, which apparently did not thrive when it was broken up into 30 state and small enterprises and cut off from virtually all budget funds, is living on the hope of being transformed into the "State Science and Production Center."[30] An already es-

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[27]Bagrov, op. cit.

[28]Lezin, op. cit.

[29]In the "Government Decree on State Science Centers" the following institutes are named as having received the status of state science center: M. M. Shemyakin and Yu. A. Ovchinnikov Institute of Bio-Organic Chemistry; N. I. Vavilov All-Russian Scientific-Research Optical Institute; the Special Astrophysical Observatory; the G. I Budker Institute of Nuclear Physics; the G. K. Boreskov Institute of Catalysis; the Institute of Nuclear Research; the V. P. Konstantinov St. Petersburg Institute of Nuclear Physics; and the Institute of Physics of Strength and Material Science. *Rossiyskaya gazeta,* December 3, 1994, p. 4.

[30]*Pravda,* May 6, 1995, p. 2.

tablished state science center, the Vavilov State Optical Institute (GOI), reports a vast improvement in its situation due to its new status, which gave it government funds sufficient to pay wages and maintain the institute.[31]

While it is too early to acquire extensive, systematic data on the impact of this federal program, preliminary reporting suggests a note of caution. A December 1994 press report noted that "the general economic crisis prevented the government from financing" the state centers as promised,[32] while Deputy Minister of Science Fonotov said that by the end of 1994 the government owed the centers "about 50 billion rubles."[33] There is no reason to expect that the discrepancies between paper allotments and actual ones, which, as discussed above, are afflicting so many budget items, should not affect the state science centers as well.

Further reservations about the potential efficacy of the program are suggested by RAND analysts Andrew J. Aldrin and Adam N. Stulberg in their illuminating findings on the process of center selection and administration.[34] The Ministry of Science is charged with making the final selection. But since the majority of would-be science centers were formerly subordinate to defense industrial ministries, the Ministry of Science lacks a thorough knowledge of these institutes.[35] Thus, an institute director's political skills in lobbying MinSci, rather than the institute's scientific strengths, are likely to determine its selection as a state science center. In addition, there is an inherent conflict of interest between MinSci, which wants to expand the number of centers under its control, and the new centers themselves, which lobby to limit the list, since the budget handed down from the Ministry of Finance does not expand to accommodate new members. Limited funding remains a crucial factor even for the new

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[31]On-site research conducted by RAND analysts Andrew J. Aldrin and Adam N. Stulberg.

[32]Bagrov, op. cit.

[33]Lezin, op. cit.

[34]These findings emerged from on-site interviews, carried out as part of a RAND research project.

[35]Ibid. Most of this expertise resides within GKOOP, which, however, has little authority to participate in the selection process.

"privileged" centers, making it likely that their allotments will permit them only to hobble along, paying wages and electric bills, without providing the material base for quality R&D.

Alternative Forms of Funding

A significant new development in Russian R&D funding is the emergence of innovative forms of nonbudget resource distribution.[36] One such form is **nonbudgetary branch funds**, established under the auspices of various ministries, concerns, and associations, whose purpose is to finance intra- and interbranch R&D. These funds accumulate monies by tithing the financial resources of individual enterprises at the rate of 1.5 percent of production cost. The distribution mechanism of such funds, however, allows the enterprises to spend money on their own projects, thereby sabotaging the funds' original purpose. In spite of this, the nonbudget funds have been described as "the only stable source for financing branch science."[37]

A second nonbudgetary source is the **Russian Foundation for Technological Development,** attached to the Ministry of Science, whose main task is to finance top-priority R&D. Its resources come from transferring 15 percent of nonbudgetary branch funds to its account. The Foundation has reportedly gone through difficult times. Recently, however, it claims to have succeeded in financing more than 350 branch projects.[38] Without further data on the Foundation's level of funding for these projects, however, its impact cannot be evaluated.

The infrastructure for supporting innovative activities, including the **Russian Fund for Inventions** (attached to the Ministry of Science), the **Scientific and Technical Fund** (attached to the Union of Scientific and Engineering Societies), **Uralakadembank** (attached to the Ural branch of the Russian Academy of Sciences), and the philanthropic incorporated bank **Nauka** (under the auspices of the

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[36]For a full survey of such sources, see Irina Dezhina, *Financing Russian Science: Searching for Flexibility,* Occasional Papers of the Georgetown University Russian Area Studies Program, No. 7, September 1994.

[37]Lezin, op. cit.

[38]Ibid.

"Russian Science" foundation), is as yet embryonic and risk-averse when it comes to providing credits for science- and finance-intensive R&D.[39] Until inflation is controlled and long-term investments become more secure, the preference of these groups to finance relatively inexpensive projects that are nearing completion will remain a rational one.

Foreign science funds such as the **International Science Foundation**, which will be discussed in detail below, are another significant resource for the floundering Russian R&D institutes.

However, if the emergence of these alternative funding mechanisms is a hopeful development, it is vital to bear in mind that all of them together amount to only a minuscule percentage of total science funding.[40] The federal budget and federal science policy remain the pivotal factors in the future of Russia's S&T base.

THE SCIENCE CITIES (*NAUKOGRADY*)

If there is a sector of the old Soviet defense science establishment in greater peril than the branch institutes, it is the science cities. Isolated both physically and economically from the ordinary life of the country, lavishly funded by the Soviet military-industrial complex, and exclusively dedicated to military goals, the *naukogrady* now find themselves lacking both financial resources and a raison d'être. Many are struggling to redirect their efforts while preserving their scientific potential; others are less fastidious about their manner of economic survival. The demise of these anachronistic entities, at least in their present form, seems all but inevitable. Yet there are those who view them as Russia's best hope for modernization and are actively trying to transform them from graveyards to incubators of advanced technologies.

Since there are no standard criteria for defining a science city, their number may be given as anywhere between 40 and 80. Defining them as monocultural towns consisting of one or more research

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[39]Dezhina, op. cit., p. 6.

[40]In 1992, nonbudgetary sources came to 3.6 percent of total science funding (4 percent of branch science). Dezhina, op. cit., p. 13.

and/or production facilities, providing physical and intellectual products for defense, Kalashnikova[41] identifies 50–55 such towns, town-type settlements and separate districts of cities, with a combined population of about 3 million. The most dense concentration of *naukogrady*—twenty—is in the Moscow area; the Ural region, with ten, comes next, followed by Siberia, with seven. Others are dispersed throughout Russia, in Tula, Yaroslavl, Nizhniy Novgorod, Kaluga, the Leningrad region, Penza, Tver, Ulyanovsk, Vladimir, and Tatarstan. Forty-nine were subordinated to branch ministries, while six belonged to the Academy. Sixteen were former secret cities.[42] Fields of activity included aerospace engineering, microbiology, biophysics, electronics, radio engineering, and related disciplines.[43]

Kalashnikova characterizes the science cities as extraterritorial, extraeconomic, and extrasocial formations: giant machines for focusing technical progress on military projects and stealing it from society. The present task of institute and laboratory heads, as she sees it, is to transform the *naukogrady,* with their "almost monopolistic ownership of high tech, most advanced knowledge, most sophisticated equipment and most able minds" into civilian technopolises, capable of taking Russia from the industrial age to the information age.[44] There are numerous initiatives to form cooperative economic ties between the science cities and their local regions: In the Moscow region, for instance, Zhukovskii, Balashikha, Ramenskoye, and others have formed the Rona-Complex Association, designed to develop interregional economic, industrial, and educational ties. Kalashnikova, on the other hand, suggests that science cities should remain supraregional, serving the nation as a whole. For these powerful scientific centers to become local consulting, engineering, and servicing centers, earning money from the local economy, would in her view be another form of disaster.

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[41]Marina Kalashnikova, "Russian *Naukogrady* as the Focal Point of Russia's Drive Towards the Future," *RUSI Journal,* April 1995, pp. 1–9.

[42]Of these, ten were closed "atomic cities," including Chelyabinsk-70 and Arzamas-16, which were centers for developing nuclear arms. Pavel Felgengauer, "The Closed Cities of Russia," *Nezavisimaya gazeta,* June 30, 1992.

[43]Kalashnikova, op. cit.

[44]Ibid.

But this vision—which reflects the view, dear to the hearts of old-line *oboronshchiki* (military industrialists), that only a reinvigorated military-industrial complex can rescue the economy—remains far from realization. There have been some conversion successes,[45] contractual relationships between defense research institutes and civilian industries, as well as attempts at closer cooperation, with defense R&D institutes developing large-scale programs for applying their technologies to entire civilian industries. The latter programs, however, are mostly in the planning stage, and lack of funding may well prevent them from ever getting any further. The massive investment required to transfer advanced technologies to the outmoded, decaying civilian plants is lacking. And government outlays, which take the form of separate line items in the 1995 budget—supplements in place of defense orders—are sufficient to pay salaries, but not to bring about structural reform. Indeed, recent reporting indicates that even provision of salary payments is beyond the state's ability to support the former jewels of its defense science infrastructure. After workers in the Arzamas-16 laboratories went on strike in early June because they had not been paid, laboratory officials warned Moscow that the upheaval could undermine security at the nuclear research site.[46]

Far from transforming themselves into modern technopolises, the science cities are at best maintaining a minimal level of subsistence, struggling to maintain cadres under a cloud of uncertainty about the future.

Researchers and engineers have been leaving for Europe and the United States, as well as for South Korea and Japan, usually on a contract basis, expecting to return. While unemployment statistics tend to be unreliable (some enterprises exaggerate in order to get relief funds, others understate personnel losses for fear of being "disqualified" for performance of funded research), science city payrolls have been halved.[47] Vladimir Belugin, science director of the

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[45]Prime examples are TsAGI's projects in the gas industry, agriculture (including equipment for greenhouses) and forestry, the food industry, transportation (including the automotive industry), ecology, and health care. Kalashnikova, op. cit., p. 7.

[46]Monitor news service, June 12, 1995.

[47]Kalashnikova, op. cit.

Scientific Research Institute of Experimental Physics (VNIIEF) in Arzamas-16, which employs 24,000, reports that "unfortunately a significant reduction of our workforce has begun, with two-thirds of those leaving (and this is 1,670 people) consisting of highly qualified cadres."[48] Perhaps most significantly, the most talented and ambitious university graduates increasingly avoid jobs in the precarious *naukogrady,* making it likely that the science cities will gradually be depleted of intellectual vitality.[49]

Indeed, with services periodically cut off due to institutes' inability to pay escalating prices for energy, water, and communications, and housing deteriorating as the federal government attempts to transfer ownership from the indigent defense institutes to reluctant local authorities, little remains of the former, relatively privileged life of the science cities to attract the young. The degree of suffering is a direct function of a science city's isolation: For those in the vicinity of large cities like Moscow, Nizhniy Novgorod, and Yekaterinburg, alternative employment is available. For those far from cities, there are few options.

Comparison of two studies of Arzamas-16, the first carried out in 1992,[50] the second in 1995,[51] suggests a process of disillusionment, fading options, and increasing apprehension about the future. If, in 1992, despite its involvement in a number of conversion projects, the science city was finding it difficult to survive, there was "cautious optimism" that near-term support would be found. Boris Nemtsov, the entrepreneurial governor of Nizhegorodskaya Oblast, was hopeful of attracting foreign investment and stimulating grass-roots initiatives in private commerce. The government, too, was expected to offer assistance. None of this has materialized in sufficient quantities. The consequences, as Zisk summarizes them, are cause for the deepest concern:

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[48]*Gorodskoy kur'yer,* December 23, 1993, quoted in Kimberly Marten Zisk, "Arzamas-16: Economics and Security in a Closed Nuclear City," *Post-Soviet Affairs,* Vol. 11, January–March 1995, pp. 57–80.

[49]Kalashnikova, op. cit.

[50]Brenda Horrigan, "The Changing Fate of a Russian 'Secret City,'" *RFE/RL Research Report,* Vol. 1, No. 47, November 27, 1992.

[51]Zisk, op. cit. Also see David Holloway, "Reflections on Arzamas-16," *Post-Soviet Affairs,* Vol. 11, January–March 1995, pp. 80–82.

> The chaos of economic reform and the breakdown of centralized power in Russia appear to be threatening the safe handling and control of nuclear materials in Arzamas-16 and in the other nine nuclear cities. The new-found combination of low state salaries and work prestige, opportunities for quick economic gain through private activity in a climate where illegality is the norm, and a low state budget for upgrading the nuclear facilities is a recipe for disaster. It is not clear that more money alone could solve these problems; it is clear that the absence of money is beginning to tear apart the fabric of discipline and morality that once held these cities together.[52]

While criminal activities in the nuclear cities pose the most serious dangers, opportunities for theft—of precious metals, of computers, and of communications equipment—are not lacking in the other science cities. Criminal attempts to profit through privatization of defense enterprises is yet another factor undermining the science cities' struggle to transform themselves into viable economic entities.

Political behavior clearly reflects the science cities' darkening mood. In June 1991, the science cities voted for Yeltsin against his closest rival, Vladimir Zhirinovsky. But as hardship conditions persisted, allegiances shifted dramatically. In December 1993, the majority of science cities voted for the Communists and Zhirinovsky's Liberal-Democratic Party. It seems reasonable to expect similar voting patterns in the *naukogrady* in 1996, as well as in 1995 parliamentary elections, if present trends continue.[53]

If, as David Holloway has termed it, "a pall of uncertainty hangs over Arzamas-16"[54]—and, I would add, the other science cities—it is not for lack of initiatives or flexibility on the part of institute directors. Scientific contacts with the outside world have been growing; innovative forms of restructuring are being tried. None of this is sufficient, however, in light of the macroeconomic conditions that keep government funding at a meager level and investment financing in R&D virtually nonexistent. In this sense, as in so many others, the

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[52]Zisk, op. cit., pp. 59–60.

[53]Kalashnikova, op. cit.

[54]Holloway, op. cit.

science cities have lost their exclusive status and face problems similar to those of the defense-industrial sector as a whole.

THE ONGOING STRUGGLE TO BOLSTER DEFENSE R&D

Defense-industrial interests, with the Kokoshin faction of the Ministry of Defense and the conservative State Committee for the Defense Industry (GKOOP) in the lead, are far from abandoning their struggle to preserve and revitalize the defense R&D sector. A steady stream of draft laws, resolutions, and policy statements, designed to strengthen and protect this sector, continues to emerge, reflecting a sense of increased urgency. At the same time, lack of both material resources and unified political will places the likelihood of realizing these initiatives under severe doubt. This can be seen by surveying significant recent developments in budget funding, support for new weapons design, and the politicization of the defense sector.

Budget Funding

Despite Kokoshin's demand, at a May 18, 1995 cabinet budget session, that military spending be increased in the 1996 federal budget, First Deputy Premier Anatoliy Chubais said defense spending in 1996 would remain at the 1995 level.[55] First Deputy Finance Minister Vladimir Petrov said that defense spending in 1996 would focus on "brand new weapons and equipment" and that spending for defense R&D programs would remain at this year's level, i.e., 10 percent of total spending on armed forces' organizational development and upkeep (or around 2.2 trillion rubles).[56] Kokoshin's response was to call this figure "unacceptably low" and unreflective of "the requirements in gaining strong positions in the world markets of science-intensive products."[57]

Meanwhile, the government's failure to implement the 1995 defense budget continues to give rise to social unrest. On June 13, one of Yekaterinburg's main streets was blocked by more than 2,000

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[55]Open Media Research Institute Daily Digest, May 22, 1995.

[56]ITAR-TASS, May 18, 1995, as reported in FBIS-SOV-95-097, May 19, 1995.

[57]INTERFAX, May 19, 1995, as reported in FBIS-SOV-95-098, May 22, 1995.

protesting workers from one of the largest electronic air-defense manufacturers in Russia, who had not been paid since February.[58] The next day, defense workers in Murmansk staged a rally demanding that the Ministry of Defense pay delayed wages and calling for the dismissal of the government.[59] The deputy chairman of the Duma's economics policy committee, Mikhail Zadornov, has sharply attacked the government's uneven method of funding some parts of the economy above budgeted levels while giving others, such as the defense sector, far less than planned.[60]

Support for New Weapons Design

In March 1995, the Russian Security Council's Interdepartmental Commission for Development and Research in the Defense Industry issued a strongly worded policy statement in favor of guaranteed state support for development of advanced arms and technologies, including plasma generators and beam and pneumatic weapons. The Commission was particularly concerned over the problems of how to "keep the country's capability to design prospective arms and protect Russian designs against uncontrolled use abroad"; it suggested introducing protectionist measures and giving tax benefits to investors in military research programs.[61] At the same time, Andrey

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[58]Open Media Research Institute Daily Digest, June 16, 1995. The director of the Vektor plant, which employs over 6,000 people, said the plant was owed about 39.5 billion rubles ($8.2 million) and that 1,500 workers had been put on compulsory unpaid leave. Monitor news service, June 14, 1995, reported that the chief of the Federation of Independent Trade Unions told *Delovoy mir* (No. 21) that there were more strikes during the first quarter of 1995 than in all of 1994; he attributed this to the drop in incomes as well as the increase in unpaid wages.

[59]Open Media Research Institute Daily Digest, June 16, 1995.

[60]Monitor news service, June 13, 1995. The degree of fluidity and even chaos associated with budget implementation is suggested by two recent reports. *Segodnya,* May 25, 1995, reported that the Federation Council had approved a bill that would guarantee payments to defense contractors outside the normal state budget. Opponents, including Kokoshin, said that such a move would bust the budget and violate the constitution; he predicted Yeltsin would veto the measure. A second *Segodnya* article (June 15, 1995), as reported in Open Media Research Institute Daily Digest, June 16, 1995, revealed that Duma members are questioning Yeltsin's decree permitting only the president to reduce or increase budget expenditures. The parliamentarians are claiming that the decree contradicts the constitution, which places budgetary issues under the jurisdiction of the Federal Assembly.

[61]INTERFAX, March 6, 1995, as reported in FBIS-SOV-95-048, March 13, 1995.

Kokoshin weighed in with proposals aimed at ensuring "reliable nuclear deterrence and the development of strategic nuclear forces, including their naval component."[62] He stressed the urgency of creating "essentially new, precision conventional weapons, reconnaissance and target indication technologies, tactical level communications in the land program" and "ways to bring Russian armor up to world standards." But Kokoshin was not optimistic about the future of his proposals, opining that none of them had been considered "at any of the government levels."

His fears were justified soon afterwards, when the Draft Law "On the State Defense Order" was adopted "in principle" by the Duma on April 21, despite claims that "the vast majority of Defense Ministry and General Staff observations [on the draft law] were simply ignored,"[63] and forwarded to the Federation Council, which approved it on May 24.[64] Intended to "regulate the basic mutual relations between the state and its bodies and enterprises, offices, and organizations which create and supply arms and military equipment,"[65] the law does not bode well for defense R&D: It removes from the targeted armament program the program of "basic and exploratory scientific research on the development of armaments and military hardware," which was an integral part of it. Clearly, whatever the convictions of defense industry spokesmen on the importance of developing new weapons technologies, they have failed to make their case with powerful parliamentary opponents.

Politicization of the Defense Sector

A deepening sense of crisis in the spring of 1995 was articulated during a series of conferences that intensified the ongoing process of

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[62]INTERFAX, March 11, 1995, as reported in FBIS-SOV-95-049, March 14, 1995.

[63]*Krasnaya zvezda,* April 6, 1995, p. 1; INTERFAX, April 21, 1995, as reported in FBIS-SOV-95-078, April 24, 1995.

[64]INTERFAX, May 24, 1995, as reported in FBIS-SOV-95-101, May 25, 1995.

[65]Ibid. While the Ministry of Defense strongly opposed the law, the GKOOP was in favor of its being passed "in any shape" because, with its help, "it would be possible, through courts, to make the government fund defense orders." Ministry of Defense spokesman Kokoshin retorted that the law is "so vague that no court will be able to use it." *Segodnya,* May 25, 1995, p. 2.

political organization within the defense sector. Delegates cited dismal statistics, made dire predictions, and offered predictable solutions.

At the first conference of the League for Assistance to Russian Defense Plants in Moscow, speakers warned that the S&T potential of the defense complex was disintegrating and, unless the government takes prompt measures, "defense enterprises will go bankrupt and the industry of high technologies and its personnel will disappear." League President Alexey Shalunov said that production in both military and civil sectors of the VPK was virtually paralyzed, with a 95 percent drop "on average" of all types of weapons production.[66]

A conference of defense enterprise directors in Novosibirsk, held at the initiative of GKOOP, focused on "how to preserve the scientific and production potential of the VPK in conditions of economic collapse." A worsening in the economic plight of Novosibirsk's defense enterprises was attributed to arrears in paying for state defense orders, as well as inadequate funding of conversion, civil science, and "maintenance of defense reserve capabilities."[67]

At the third conference of the League to Support Defense Industry Enterprises held in Moscow on April 19, 1995,[68] executive director Viktor Alferov, noting that the continued lack of a weapons program for Russia left defense industry prospects "completely unclear," claimed that the best means of survival for the VPK was to create its own political party. His proposal was "almost unanimously" adopted by the conference, which also considered creation of a special VPK lobby in the government and Duma. The defense industrialists rejected the newly formed Industrial Party as its representative, claiming its founders were mired in their own problems. Significantly, delegates singled out the fuel and energy complex as the VPK's "main rival in the struggle to survive," stating that the high cost

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[66]ITAR-TASS, April 19, 1995, as reported in FBIS-SOV-95-077, April 21, 1995. Unfortunately, the report does not specify over what time period this drop took place.

[67]A. Yugrina, "Defense Sector Needs Government Guarantees; Notes from the Conference," *Sovestskaya Sibir,* April 19, 1995, p. 2.

[68]Demyan Belyakov, "The VPK Is to Create Its Own Party, Conversion Has Lost Its Sense," *Nezavisimaya gazeta,* April 20, 1995, p. 2.

of energy posed an urgent threat to both the VPK and "Russia's interests."[69]

The conference discussed the latest GKOOP data, which showed that the production rate of defense enterprises was 28 percent of the 1991 level and that, for the first time, the rate of decline in nonmilitary production surpassed that of military production, thereby obliterating "hopes to escape poverty through conversion." But defense industrial leaders blamed the crisis not on the absence of government funds, but on a lack of fiscal discipline at the Defense Ministry, and they proposed shifting several of the ministry's functions to GKOOP, which enjoys greater trust. A more balanced analysis, of course, would have to consider both funding shortfalls *and* poor financial discipline.

The GKOOP has been neither passive nor silent in the ongoing debate. Its head, Viktor Glukhikh, warned that Russia could be left without any new weapons[70] and announced that arms sales would be "noticeably" increased, since in his view there is no other way of attracting investment into the arms industry. Beyond this, Glukhikh announced that his committee had signed agreements with several

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[69]The threat posed by high energy prices was dramatically stated by a senior officer in Russia's Strategic Rocket Forces, who noted that "we live in constant fear of having our electric power shut off," as occurred in October 1994. He added that inadequate government funding could leave Russia without a nuclear arsenal by the year 2005, when the SS-33 delivery rockets will have outlived their projected useful life. Monitor news service, June 7, 1995.

[70]Glukhikh reported that Russia is building only one new submarine, that three out of five tank plants have been closed, and that the Air Force, which has not received a single new plane in the past four years, will not receive a single new fighter this year. INTERFAX, April 18, 1995, as reported in FBIS-SOV-95-077, April 21, 1995. This report appears to be contradicted, or at least moderated, by a description of Defense Minister Pavel Grachev's recent visit to the aircraft flight testing center in Zhukovskiy, where he was shown "the 21st century multi-purpose fighter plane and other new aircraft" developed there. Grachev expressed his satisfaction with the progress achieved in modernizing fighter planes and bombers and noted that sufficient allocations were made to carry out research, experimental, and design efforts, due to monies generated by the sales of equipment and provided "thanks to the personal attention of the President and the head of government." ITAR-TASS, June 6, 1995, as reported in FBIS-SOV-95-108, June 6, 1995. The most probable conclusion is that Glukhikh was exaggerating in order to make his point; a small number of high-priority defense R&D programs continued to be funded. It is also possible, however, that Grachev's "expression of satisfaction" is disingenuous and that the aircraft development programs are not going nearly so well as he would have the public believe.

banks on financing a number of conversion programs, since the government allotment for conversion in 1995, "a mere 1.4 trillion rubles" is deemed "many times less than necessary." He also announced that GKOOP was developing a doctrine for boosting defense technology to the years 2005–2010, aimed at focusing limited government funds on the development of key weapons systems.

Finally, Defense Minister Grachev joined the chorus of alarmed voices by describing the VPK as "now falling apart and losing millions of jobs, thus increasing the army of the unemployed." His solution, however, is not likely to be universally embraced: Grachev offered to solve all budget problems by having the VPK take control of arms exports from the state agency *Rosvooruzheniye.*[71] While there is thus no shortage of initiatives to rescue the defense R&D sector, the above survey of recent events makes clear that:

- Despite efforts at unification, the defense industrial sector is politically splintered both among and within various agencies, ministries, departments, government, and Duma committees.
- The illusion of salvation through government subsidy, while abandoned by some realists, still plays a major role in the mentality of the *oboronshchiki.*[72]
- Despite much evidence to the contrary,[73] belief in the ability of arms sales to finance the revitalization of defense industry per-

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[71]ITAR-TASS, May 4, 1995, as reported in FBIS-SOV-95-086, May 4, 1995. See Alexander Zhilin, "The Marshal Has Come Out of the Trenches," *Moskovskie novosti,* May 7–14, 1995, p. 8, for an analysis of Grachev's attempt to seize the reins of arms sales from the scandal-plagued *Rosvooruzheniye* as a counterattack against Alexander Korzhakov, Yeltsin's close advisor, who has said that the army should be headed by professional insiders, not "generals with tradesmen's habits."

[72]*Kommersant-Daily* ran an article on this phenomenon on August 30, 1995, noting that many officials believe that remaining or returning to the status of state-owned enterprises is the only way the defense industry can survive. The paper's view was that few defense firms would be saved by such a "socialist" approach. Monitor news service, August 31, 1995.

[73]Evaluation of the arms sales issue exceeds the scope of this report. Negative expectations for the future of Russian arms sales are reported by Vladimir Zadera, ITAR-TASS, May 19, 1995, as reported in FBIS-SOV-95-098, May 22, 1995:

> According to foreign analysis, the volume of the world arms market to the year 2000 is assessed at approximately $40 billion a year, and it will be decreasing. By the late 80s the USSR accounted for 38 percent of the arms

sists on the highest level, among such figures as Defense Minister Grachev, deputy chairman of the GKOOP Gennadiy Yanpolsky, first deputy Defense Minister Andrey Kokoshin, and Prime Minister Chernomyrdin.

Even in the wholly unlikely case that the stubborn dreams of the defense industrialists were to be realized, through bounteous state supplements and/or highly profitable arms sales, money alone would no longer allow them to rebuild their sector to anything resembling its former glory. The drying up of the defense order over the past several years has had a long-term effect, not only on defense institutes, but on the entire network of science institutes, in civilian industry, in the Academy of Sciences, and in the universities. Vital human and material resources have been either lost or diverted away from military projects to other ends.

Despite these losses, a renewed defense industry is still seen by many as the best hope for overall economic advancement and development of state-of-the-art defense technologies. The fact that in the Western democracies these goals have been achieved by a robust civil scientific-industrial base, driven by consumer demand, has yet to be fully appreciated by the government and translated into industrial policy.

The next chapter will examine the soil from which such a civil R&D sector is struggling to grow in Russia.

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market, the United States for 20 percent. According to U.S. sources, the U.S. share by the year 2000 will amount to 60 percent, while Russia's to only 5–6 percent.

Another pessimistic assessment is offered by Pavel Felgengauer, "Arms Trade Is Not So Beneficial to Russia as Rosvooruzheniye Makes Out. Longstanding Partners Are Inclined to Pay for Submarines with Footwear While New Ones Are Disappointed with the Performance of Russian Tanks in Chechnya," *Segodnya,* March 10, 1995, p. 2.

Chapter Three

CREATING A ROBUST CIVIL S&T SECTOR

By default rather than decree, Russia has begun the haphazard, still embryonic process of developing a civil S&T sector, capable of transforming the fruits of basic science into commercially promising advanced technologies.

The question of what such a sector would require is an extremely broad one, encompassing political, economic, social, and psychological factors, in addition to those elements intrinsic to the R&D process itself:

- a well-financed, well-equipped research base, with free access to the international science community;
- a steady stream of new, talented scientific cadres emerging from the higher educational institutes;
- retention of well-qualified older scientists (staunching the internal and external brain drains);
- development of enlightened management, which rewards individual initiative and scientific innovation;
- creation of flexible organizational structures, capable of bridging the gap between R&D and production;
- creation of innovative financial arrangements; and
- adoption of state measures providing incentives for investment in R&D.

All of these elements will be considered in the following discussion.

THE CHANGING SHAPE OF BASIC SCIENCE

After more than three years of predictions of their imminent collapse, the bastions of Russian basic science—the Russian Academy of Sciences (RAN) and the network of higher educational institutes (VUZy)—though debilitated, are seemingly intact. Both the degree of debilitation and whether conditions exist for a timely reversal of this process are the subjects of endless, heated debate within Russian scientific circles. That RAN has not only survived but produced significant scientific results was affirmed by its president, Yuriy Osipov, at the Academy's annual general meeting in April 1995.[1] A similar assertion was made at the annual meeting of the State Committee for Higher Educational Institutions (GOSKOMVUZ) by its first deputy chairman, Alexander Tikhonov, although, interestingly, he rated the other two major sectors of Russian science rather less optimistically: "Academy and branch science are still in a state of crisis, while we are finding a way out."[2]

Indeed, the diametrically opposed opinions that turn up in discussions of the survival of one or another sector of Russian science appear to be a function of the affiliation of the speaker and the goal of his remarks. These dynamics, of course, are not specific to the Russian scene. If annual meetings are occasions for rallying the membership with whatever good news is available, then parliamentary hearings on budget funding for science are appropriate forums for doomsaying. A third factor is one's definition of "survival," and here, as the following quotation makes clear, one must be willing to stretch the term to its limits to come out on the side of unrelieved optimism:

> The [Academy] institutes are surviving, even if there is scarcely a glimmer of light in some of them; research is going on; scientists, although with a lag, are receiving their wages and going on foreign missions. All the directors remain in their posts. . . . The situation of unstable equilibrium, after a second look, is extremely stable.[3]

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[1]V. Romanenkova, "A Difficult Time for RAN," *Inzhenernaya gazeta,* No. 33 (640), April 1995, p. 1.

[2]"In the Dark, but Not Blind," *Poisk,* No. 5 (299), January 28–February 3, 1995, p. 3.

[3]Vladimir Pokrovskiy, "Predictions and Threats. Period of Semi-Decay of Science Lasts Three Years," *Segodnya,* September 1, 1994, p. 1.

If survival is equated with the fact that institute buildings remain standing (though physically deteriorating and housing increasingly outmoded instruments and equipment), that some research is going on at some institutes (while others are essentially idle), that scientists are eventually paid (though at low rates and with ever greater delays), that the best and brightest scientists go abroad, with many who planned to return staying away indefinitely, and that institute directors remain at their posts, hampered by continual uncertainty about funding, then perhaps a consensus can be reached that basic science is surviving. This "victory," however, will be purely rhetorical and will not take us far in answering the more fundamental questions:

- What direction is the crisis in science taking? Is it possible to discern in recent developments a sea change for the better, or is the downward trend in funding and state support continuing?
- At what point do the "reserves" of scientific potential (including aging cadres, facilities, and equipment, as well as dwindling foreign funding), which have sustained a sense of continuity in scientific life, run out?
- How long can the present "crisis" continue before basic science falls irreparably behind in essential fields?
- Beneath the facade of continuity, how is basic science restructuring itself to assure its future?
- What can evolving funding mechanisms and organizational innovation hope to achieve without sufficient investment, whether foreign or domestic, in R&D?

Before embarking on a discussion of these interrelated issues, a caveat should be added. As analysts, we must consider the means we have for understanding and following the trends in Russian science. We should be aware that our reporting mechanisms may skew our view to place overly great emphasis on the decline of existing institutions while underplaying the emergence of new ones that may be taking shape in a form we are not trained to recognize in the Russian setting.

The 1995 Science Budget: The Pattern Repeats

Aligning himself with the "optimists," Science Minister Boris Saltykov alluded to "small victories" in increasing the 1994 science budget, which spawned hopes that 1995 would be even better and that the downward trend of the past few years was about to be reversed.[4] Whatever victories the minister was alluding to failed to impress RAN president Osipov, however, who spoke of 1994 as a year of continued negative trends in Russian science and, above all, of "the relentless reduction of budget allotments." Expenditures for science were at 0.6 percent of the GNP, "less than that of many underdeveloped countries."[5] Table 3 indicates the discrepancy between allotted and actually distributed funds for the central section of RAN[6] for the first three quarters of 1994.

Thus, during the first nine months of 1994, RAN received 200 billion rubles, or 70 percent of its approximately 284 billion allotment for those nine months;[7] no improvement was expected during the fourth quarter.

Table 3

Russian Federation Ministry of Finance Plan for Funding the Central Section of RAN and Its Actual Implementation

	Quarter (millions of rubles)				1994
	I	II	III	IV	Total
Plan	53,550.6	109,013.3	121,320.8	143,224.3	427,109.0
Actual funding	53,550.6	58,581.5	87,905.0		
Percentage of planned funding implemented	100.0	53.7	72.5		

SOURCE: *Vestnik Rossiyskoy Akademii Nauk,* 1995, Vol. 65, No. 2, p. 181.

[4]Ibid.

[5]Romanenkova, op. cit.

[6]This does not include the Siberian, Ural, and Far-Eastern branches.

[7]This situation was an improvement, however, over the third quarter of 1993, when RAN received only 60 percent of its allotted funds. *Vestnik Rossiyskoy Akademii Nauk,* 1994, Vol. 64, No. 7, p. 662.

According to Academician Osipov, RAN eventually received 514 billion rubles and *failed* to receive 170 billion of its allotted funds.[8]

As significant as the amount of budget funds received by RAN in 1994 is the manner of its distribution: about 48 percent went for salaries; about 35 percent went for heat and electricity, communal services, and "extra" salary charges; and only 17 percent was applied directly to equipment, supplies, and other (nonsalary) expenses accrued in performing scientific work.[9]

In the 1995 federal budget, of the 1.775 trillion rubles designated for basic research, RAN was allocated the lion's share of 687 billion.[10] This figure was in itself a disappointment: although 40 percent greater than the figure the government had originally proposed for RAN, in real terms it amounted to only 65–70 percent of the previous year's allotment[11]—far less than Academy officials had claimed as the bare minimum for keeping its institutes afloat in 1995. Moreover, the implementation of the budget plan for the first quarter of 1995 was considerably worse than for the comparable time period in 1994, when the full quarterly allotment was actually received. RAN officials report that the government's promise to "strictly" carry out the 1995 budget and repay its 1994 debt has not been fulfilled. In the first quarter of 1995, the Academy received 60 billion rubles each month. The second quarter promised to deliver even less: in April the Academy received 50 billion rubles, and in May only 46 billion was expected.[12] Thus, during the first six months of 1995, the Academy was expected to receive less than 60 percent of funds allocated for that period.[13]

This latest crisis in RAN funding has led to predictions of the disintegration of institutes and laboratories, massive firings, and putting

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[8]Yuriy Osipov, "The Leadership Has Aligned Itself with Science," *Poisk,* No. 13 (307), March 25–31, 1995, p. 1.

[9]Ibid.

[10]*Rossiyskaya gazeta,* April 7, 1995, p. 4. Appendix B lists Russia's 1995 federal budget appropriations for basic research.

[11]V. N. Sobolev, "No Changes," *Poisk,* No. 18 (312), April 15–22, 1995, p. 1.

[12]*Poisk,* No. 21 (315), May 6–19, 1995, p. 2.

[13]Sobolev, op. cit.

workers on unpaid leave. In April, RAN workers in St. Petersburg, Novosibirsk, Vladivostok, Irkutsk, Petrozavodsk, and Pushchino united in demanding that the government resign and new presidential elections be held ahead of time.[14] The fact that RAN workers were on the verge of strike in June 1995, just as they were in June 1994, underscores the sad consistency of the budgetary process: allocation of inadequate sums for S&T, little more than half of which is actually distributed.[15]

It would appear that the VUZy are faring even worse. In early April, the chairman of the GOSKOMVUZ, Vladimir Kinelev, spoke of his sector's victory in obtaining a 30 percent increase in budget funding over the previous year. Kinelev was willing to write off 1994's indebtedness, as long as the situation did not repeat itself in 1995.[16] This, however, is precisely what happened. With the government providing only 10 percent of the funds necessary to operate the country's schools, many schools lack heat, water, and electricity. Scholars at the Academy of Sciences were planning a June 12 hunger strike to protest budgetary shortfalls for educational institutions.[17] As for the VUZy research budget, it has been described as "pitifully small" by GOSKOMVUZ's Tikhonov—13 to 14 billion rubles per year, with 46 percent going to basic science.[18]

The Impact of New Funding Mechanisms

On the basis of federal budgeting patterns alone, one would be tempted to join the chorus of voices predicting the imminent demise of Russian science. But a series of factors suggest that other, more positive dynamics are at play. In a 1993–1994 expert opinion poll

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[14]Ibid.

[15]For a full discussion of the June 1994 budgetary crisis, see Yu. Guldina, "Let Me Remind You . . ." *Poisk,* No. 23, June 10–16, 1994, p. 1.

[16]Yelizaveta Ponarina, "The White House. Unexpected Science," *Poisk,* No. 16–17 (310–311), April 8–14, 1995, p. 1,

[17]Monitor news service, June 7, 1995.

[18]"In the Dark, But Not Blind," op. cit. See Appendix C for federal budget allocations for higher education.

sponsored by the Ministry of Science,[19] two points of view were expressed: (1) that the collapse of science is already underway and is (almost) irreversible, and (2) that along with collapse, there is a certain revival: genuine scientists remain, healthy competition is gaining ground, phony research is decreasing, and some valuable innovations are being put into practice. If, as most respondents agreed, this second evaluation is the correct one, then it is largely due to the influence of new granting sources, which have provided substantial infusions of hope for scientists and are introducing new dynamics into the funding of basic science.

International Science Foundation (ISF). Foremost in both the amount of funds it has contributed to basic research and in its potential long-term impact in shaping the mechanisms of Russian science funding is the ISF, a foundation underwritten by American financier and philanthropist George Soros and commonly referred to as the Soros Foundation.[20] Since its inception in 1992, the ISF, which does not support applied scientific programs tied to military goals or commercial projects, has contributed approximately $130 million to basic science in the FSU and the Baltic countries. The foundation spent about half of its original $100 million benefaction—$47 million—on long-term research grants to individual research teams.[21] In addition, the foundation offered "emergency grants," infrastructure support (telecommunications, conference, travel, and library assistance), as well as support for educational programs. In its own estimate, the ISF has "made it possible for many research institutes to stay open, allowed talented scientists to continue to pur-

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[19]Ludmila Yu Bzhilianskaya and Leonid Ya. Kosals, "Basic Research in Russia: Is There Any Time to Solve Problems?" presented at the International Institute for Applied System Analysis, Laxenburg, Austria, March 6–7, 1994. This was a small sample, consisting of seven Academy scientists and two from Moscow State University, drawn from the fields of physics, mathematics, chemistry, biology, earth science, economics, history, and ethnography.

[20]The ISF represents just 1/25 of all Soros's funding activities in the FSU and former Soviet bloc. There are at least 23 other Soros organizations, most of which focus on cultural, media, and educational institutes that "build open societies." Personal interview with Gerson Sher, head of ISF Washington office, April 27, 1995.

[21]Expecting 4,000 applications, they received 15,000 (Sher interview). Russia received the lion's share—2,876—of long-term research grants, with the next-highest number—318—going to Ukraine. *International Science Foundation: 1994 Annual Report,* Washington, D.C., p. 7.

sue promising avenues of research, given international recognition to leading research teams throughout the FSU and Baltic countries, and encouraged young investigators to stay in science."[22]

The largest number of grants was made in physics (33 percent of the whole), followed by biology (22 percent), and chemistry (20 percent).[23] Table 4 shows the top recipients of grants. Of the institutions receiving the largest number of awards, the prominence of university science is striking and gives the lie to the long-held belief that VUZy research is inferior to the work of Academy institutes. At the least, it appears that the more substantial universities, such as Moscow State, can compete with any Academy institute in certain areas.[24]

By keeping its promises when so many foreign agencies have not, the ISF created hope within a skeptical scientific community, which doubted both its ability and intention to follow through. According to Gerson Sher, head of the ISF's Washington office, this change of attitudes in both individuals and at the institutional level may be the foundation's main accomplishment: "Even those who failed to receive grants saw that we supported a lot of good people." And by supporting "good people," the ISF helped assure that they would remain in science, thus keeping the inevitable downsizing of Russian science from becoming a completely random process.

The positive assessment of the ISF's essential role is fully confirmed by Russian scientists, who have been virtually unanimous in their praise. This report from St. Petersburg suggests both the impact of ISF programs and the level of Russian gratitude:

> It is hard to overestimate the importance of [ISF] investment in our education and science. Many Petersburg scholars and even entire

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[22]Ibid., p. 1. ISF statistics indicate that about half of grantees are under the age of 40.

[23]Ibid., p. 8.

[24]The observations of an American scholar who was intimately involved in the granting process offer another perspective on the pool of grantees. In his view, not all of the best scientists applied for grants: "A number of Academy scientists refused to participate in the ISF competition, either because they disdained the process, had never written a grant proposal, were offered opportunities abroad, or thought the amount of funding too small for their large projects."

Table 4

Top Institutions by Number of ISF Awards in Long-Term Research Grant Programs

Institution	Number of Awards
Moscow State University, Chemistry Department	87
Ioffe Physico-Technical Institute, St. Petersburg	77
Semenov Institute of Chemical Physics, Moscow	64
Lebedev Institute of Physics, Moscow	52
Institute of General Physics, Moscow	51
Moscow State University, Physics Department	48
Institute of Applied Physics, Nizhniy Novgorod	40
Nesmeianov Institute of Organoelement Compounds, Moscow	39
Moscow State University, Belozerskiy Institute of Physico-Chemical Biology	37
Institute of Nuclear Research	37
Shirshov Institute of Oceanology, Moscow	36
Moscow State University, Biology Department	35

SOURCE: *International Science Foundation: 1994 Annual Report,* p. 9.

> institutes can function at a proper level today strictly thanks to the ISF.... The Ioffe Institute, for example, received 680 grants of $500 each, within the framework of urgent individual assistance. People could spend this money any way they wanted—for food, books, vacations. The twenty-five $1,500 grants, on the other hand, were given to science groups and $37,500 was awarded to purchase equipment for the Institute. Ioffe also received forty-four long-term grants. In addition, there is a library program, support to travel to international conferences.... Over 1993–1994, all in all our city will receive about $6 million from the ISF. So in the end, it turns out that St. Petersburg's scientific potential is being preserved... by an American financier.[25]

The extent to which the Russian science community feels itself beholden to George Soros was dramatically demonstrated when the ISF, along with a number of other foreign philanthropic and research organizations, was accused of engaging in subversive activities, in a report prepared by the Federal Counterintelligence Service (FSK) and

[25] *Nevskoe vremya,* August 3, 1994, p. 1.

published in *Nezavisimaya gazeta.*[26] Duma hearings held to investigate Soros turned instead into a forum for condemning the government's failure to fund science, culminating in a motion to give Soros "the highest medal" rather than censure him. While Soros's accusers failed to appear, the science community, including Science Minister Saltykov and several RAN vice presidents, turned out in force to pay homage to his work. Several participants picked up on a remark made by Nikolai Karlov, rector of the Ioffe Institute, who quoted Zola's dictum that a man wishing to possess a woman totally must fill all her needs and compared it to the Russian government's desire to "fully possess" Russian science.[27] However fanciful the analogy, it points to the very real possibility of Russian science becoming dependent upon foreign sources, a situation bound to cause uneasiness in government circles and stimulate nationalistic paranoia.[28]

One may speculate that prior recognition of this danger played a role in Soros's decision to discontinue the ISF's original programs, once the $130 million was spent. After funding 3,400 grants in 1994, Soros took steps to shift the burden to federal governments. His invitation

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[26]*Nezavisimaya gazeta,* June 10, 1995. Many organizations were named, but because Soros was the only one to make a public statement denouncing the FSK report, it became known as the "anti-Soros report." A week later, one of Zhirinovskiy's deputies got up in the Duma and demanded an investigation of the FSK. Speculating on the motivation for the attack, Gerson Sher notes that the FSK report's strange failure to mention those groups working with weapons scientists (such as Nunn-Lugar, the International S&T Center, U.S. Department of Energy, and NASA) points to a Soviet-style provocation. Soros himself attributed the accusations to part of "a campaign to isolate Russian scientific investigations and establish totalitarian control over Russia's intellectual life." "Soros' Millions: Scandal Unites Continents," *Poisk,* No. 5 (299), January 28–February 3, 1995, p. 1.

[27]Dmitrii Mysyakov, "No Satisfaction," *Poisk,* No. 8 (302), February 8–14, 1995, p. 1.

[28]Continued attacks on Soros fully reflect this mentality. In May 1995 the highly conservative *Sovetskaya Rossiya* published a report by Duma Security Committee Chairman Victor Ilyukhin, charging that a number of Soros employees are CIA agents. Ilyukhin declared that the ISF's main function is to train "Soros professors," thereby changing "the mentality of Russian society." Blame for the "Black Tuesday" of October 1994, when the ruble lost about one-quarter of its value, was also placed at Soros's door. Ilyukhin proposed that the Duma more strictly regulate foreign philanthropy, especially in science. Open Media Research Institute Daily Digest, May 18, 1995. The Ilyukhin "accusation" reeked of antisemitism. Soros's Jewish background was pointedly alluded to, and the list of Soros grantees mentioned only scientists with recognizably Jewish surnames. Dmitriy Mysyakov, "Soros' Millions: If There Is No Water in the Faucet . . . ," *Poisk,* No. 22 (316), May 20–26, 1995, p. 1.

to the Russian government to match a new benefaction of $12.5 million was accepted, and according to reports, $25 million for science in 1995 (in excess of the planned budget allocation for science) has been put "in the bank."[29] Knowing how the Russian federal budget is implemented, Soros directed that ISF monies be allocated in concert with receipt of the Russian monies. As to whether the Russian monies would, in fact, be forthcoming, ISF program director Gerson Sher was optimistic, noting that Ukraine has pledged $1.5 million, while Estonia has already spent $500,000 of its own money in a matching grants program. Sher believes that these are real commitments, spurred by government appreciation of ISF's fulfilled promise—not only to distribute the designated amount of funds, but to award grants fairly, using the time-tested peer review mechanisms employed by the National Science Foundation (NSF) and the National Institutes of Health (NIH). Soros has insisted that government matching grants be new monies, not just reallocations of funds from one part of the science budget to another. While Sher admits that there is no way to verify that they *are* new monies, even if they are not, "we know that this money, which is 30–40 percent of the Russian science budget, is being awarded meritoriously. That means new structures are being generated." By establishing its credibility, the ISF has fulfilled its second goal: to promote new approaches to funding and managing research.[30]

As part of this process, ISF will now function as a service organization, by offering to other foreign donors its successful, painstakingly created infrastructure for distributing help to science: freedom from taxes and customs duties; a mechanism for distributing funds in the form of checks that Russian banks will exchange for foreign currency; and a Western system of accounting and grant management.[31] The absence of such reliable mechanisms of supply and distribution of aid has been a formidable obstacle to aiding science and education, as well as to setting up joint programs. Yet despite these obstacles, Western governmental and nongovernmental organizations allo-

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[29]"An American Dollar Plus a Russian Dollar," *Poisk,* No. 40–41 (282–283), October 15–21, 1994, p. 1.

[30]Sher interview.

[31]"New ISF Initiative," *Poisk,* No. 5 (299), January 28–February 3, 1995, p. 5.

cated $30 million for 1995.[32] Approximately 50 percent of Russian basic science is currently financed by international sources: the ISF, the International Scientific and Technical Center (ISTC), the International Association for Cooperation Between Scientists of the Independent States of the FSU (INTAS), and others.[33] Thus, the extent to which foreign donors take up Soros's generous offer will be a crucial factor in the continued, widened flow of essential grant monies to the Russian scientific community.

In a striking new development, a well-known Russian banker has announced that the time has arrived for Russian business to join Soros in his efforts. Boris Berezovskiy's Logovaz Bank empire allocated $1.5 million to finance the participation of Russian scientists in international conferences. While the sum involved is a small one, it may be a significant indicator of a new willingness on the part of Russian business to support science.[34]

Russian Foundation for Basic Research (RFFI). This Russian organization is playing an important role in establishing joint projects with foreign donors and carrying forward the Soros model of science funding.

The most likely candidate to become "the Russian National Science Foundation" is the RFFI, the organization that will assume the role of evaluating grant proposals under the ISF–Russian government matching grants program.

Its original and primary function, however, is to hold its own grant competitions. Established in January 1993, it is assigned 3 percent of all federal budget allocations for science.[35] ISF's Sher believes that the RFFI, which implements peer review, albeit "not in quite the

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[32]Ibid.

[33]Vladimir Fortov, "The RFFI in 1995," *Poisk,* No. 19 (313), April 22–28, 1995. Academician Fortov is the RFFI chairman.

[34]Monitor news service, September 14, 1995. Berezovskiy has been described as both a firm Yeltsin supporter and an active participant in Prime Minister Viktor Chernomyrdin's bloc, Our Home is Russia. Logovaz was recently instrumental in restoring Vitalii Tretyakov to his editorship of *Nezavisimaya gazeta,* the financially troubled newspaper created by Tretyakov. Open Media Research Institute Daily Digest, September 19, 1995.

[35]Dezhina, op. cit., p. 3.

same way we or the NSF do it," will do a creditable job. A couple of years ago, he said, there was real cynicism about its potential impact, since the director was a former RAN vice president "who thought he could do things in the good old boys' way"; now, however, although "they are never going to look like the NSF," Sher perceives them as moving in the right direction.[36] A respondent in the aforementioned expert poll, offered the highest praise of the RFFI by saying of it, "Money is allocated without—or almost without—favoritism." That the RFFI's system of peer review is a worthy one is suggested by the substantial overlap (as high as 80 percent in some fields) between organizations funded by it and those selected by the ISF.[37] In its 1995 grant competitions, the RFFI reviewed about 12,000 applications, funding about one out of four, in the fields of mathematics (mechanics, informatics), physics and astronomy, chemistry, biology and medicine, earth science, the humanities, and the social sciences. The size of average grants is modest, falling between 20 and 26 million rubles, "depending on what amount of the budget funding for basic science is actually distributed." The Academy retained its leading position; research groups at RAN institutes received 45 percent of all grants. But it was a VUZ institution, Moscow State University, that set the record for the greatest number of awards: of the 835 applications submitted by its scientists, 299 (or 36 percent) were funded.[38]

Clearly, the new granting competitions, both foreign-sponsored and domestic, are having a vital impact on both Academy and VUZ science:

- Apart from the sustaining effect of the funds themselves, the competitions are changing traditional bureaucratic structures. If the Academy has retained its prestige as the elite institution of basic science, it has nonetheless been weakened as a centralized organization. Since its Presidium, which allocates budget funds to the institutes, is increasingly unable to pay salaries and electric bills, much less buy new equipment, its influence over member institutes is waning. As institutes and individual research

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[36]Sher interview.

[37]Fortov, op. cit., p. 3.

[38]Ibid.

groups compete for grants and devise other schemes for supporting themselves, they are increasingly independent. What this means is that decisionmaking—on research topics, organizational restructuring, salary levels, etc.—is less and less the domain of a centralized bureaucracy and increasingly that of the institutes and their scientists.

- By helping ensure the "survival of the fittest," competitive funding will contribute, along with low budget funding, to the demise of the weaker institutes and research groups. Such a process is de facto carrying out the necessary "weeding" that the Academy leadership, by scattering inadequate funds across the full spectrum of institutes, has been unable to do.
- By singling out outstanding research groups within larger institutions, the competitions are raising the prestige (and the activity level) of VUZ science. Although the migration of all basic science from the Academy to the universities, which many predicted and espoused at the outset of the science crisis in 1991, has not occurred—and is not likely in the foreseeable future—a merging of Academy and VUZ science *is* taking place on some level, as individual groups from both sectors increasingly engage in joint projects.
- And finally, the competitiveness of Russian science funding is bringing about a rapprochement, not only of Academy and VUZ science, but of branch science as well, as groups from all three sectors explore avenues for transferring scientific developments to marketable products.

All of these incipient trends may in the medium and longer terms lead to the emergence of a leaner, more flexible and less centralized S&T infrastructure, in which institutional favoritism and isolation is replaced by competition and cooperation between strong research collectives.

THE GROWTH OF A COMMERCIAL R&D SECTOR

If development of a commercial R&D sector is a condition for financial survival of S&T institutes in the new "market-oriented" climate of today's Russia, it should also be seen as the latest attempt to overcome one of the great weaknesses inherited from the Soviet econ-

omy: the gap between science and production. That the overwhelming majority of scientific developments never went beyond the laboratory was a widely recognized problem in Soviet times. The leadership hurled itself repeatedly at the problem to no avail, for it failed to address the basic underlying causes: a quota-oriented economy that punished rather than rewarded innovation and a bureaucratic structure in which autarkic, vertical hierarchies failed to communicate or interact. The highly touted initiative of the Gorbachev regime, creation of a network of interbranch scientific-technical complexes (MNTK), was designed to link Academy institutes with industrial design bureaus and production units in the interests of developing advanced technologies. A typical Soviet top-down solution, it was doomed from the start by the government's failure to adequately fund its ambitious vision, as well as by the tenacity of an ingrained *apparat,* inflexible in its style of management and fearful of losing power.

At the same time, in the freer atmosphere of the *perestroyka* years, entrepreneurial scientists were making their own stab at the problem by organizing themselves into small, flexible "S&T cooperatives," aimed at commercializing scientific developments. Moonlighting operations, housed on the premises of the larger institutes where their members continued to collect paychecks, utilizing the institutes' scientific results, equipment, and even expense accounts, the S&T co-ops were simultaneously maligned as parasites and hailed as moneymakers for the NIIs, which were floundering under the new system of "self-financing." For a brief period they appeared to flourish; but today, such innovations of the late 1980s, according to at least one study, have "quietly disappeared."[39] I believe it is more accurate, however, to speak not of the disappearance of the S&T co-ops but of their transformation into today's "small S&T firms." The renaming of things carried great weight in the ideologically torn last

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[39]See Ye. Z. Mirskaya, "What Scientists Think About Their Present and Future," *Vestnik Rossiyskoy Akademii Nauk,* Vol. 64, No. 9, 1994, pp. 771–796. This article reports on a RAN pilot study, which polled 412 scientists from 13 institutes. Only 2 percent of respondents were aware of the presence of scientific cooperatives in their institutes, and 80 percent of respondents did not bother to answer the question about their personal participation in such innovative groups (p. 776). It is on this basis that the author concludes, "In other words, the innovations of the late 1980s played no noticeable role and the initiative-oriented, independent structures basically vanished quietly."

years of the Soviet Union, just as it does in Russia today. With the cooperative movement as a whole increasingly discredited as "corrupt" and "anti-Soviet," the name "S&T cooperatives" appeared less and less frequently, steadily replaced by the more respectable rubric "small business" or "small enterprises" (*maliye predpriyatiya* or MPs).

Small S&T Firms. That the encouragement of small business remains a fixed element of economic policy is reflected in Item 11 of the 1995 federal budget, which allocates all of the funds (less than 6 billion rubles)[40] designated for "Development of Market Infrastructure" to "Small Businesses and Small Enterprises." In August the government announced that it would allocate more than 1.8 trillion rubles ($408 million) to support small and medium-sized businesses in 1996–1997.[41] And that the government envisions small business playing a role in state programs and is creating the legal basis for them to do so is enshrined in a December 1994 decree, designed "to establish the necessary conditions for broader participation by small nonstate enterprises in state programs and order for state needs, . . . including state defense orders."[42]

What is more difficult to ascertain is the current health of the small business sector as well as its direction. Available reporting is both scanty and contradictory, both for the sector in general and for small S&T enterprises in particular. Table 5 depicts the number of such firms. The figures in the table are considerably lower—less than half the number—than those reported in the same journal in February 1995. For those numbers see Table 6, which presents figures reported by the State Committee for Statistics (GOSKOMSTAT).

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[40]*Rossiyskaya gazeta,* April 17, 1995. This sum by no means reflects the full state allotment for small business. Over 24 billion rubles were appropriated by the Fund for Support of Entrepreneurial Activities and the Development of Competition of the State Anti-Monopoly Committee. Moreover, local governments invested 50 billion rubles, with the largest sums spent by the Belgorod, Novgorod, and Moscow regions, and the Karelian Republic. ITAR-TASS, April 17, 1995.

[41]ITAR-TASS, August 17, 1995, reported by Open Media Research Institute Daily Digest, August 18.

[42]*Rossiyskaya gazeta,* December 19, 1994, p. 2, "Decree No. 1322 of Russian Federation Government of 1 December 1994 on Measures to Secure Participation by Small Nonstate Enterprises in State Programs and Orders for State Needs."

Table 5

Number of Small Enterprises Registered on January 1, 1994, by Form of Ownership and Branches of the Economy

	State and Municipal	Private	Public Associations	Mixed	Total
Enterprises: total	46,479	362,355	4,552	67,576	479,962
Providing science-related and scientific services	3,044	22,914	608	8,214	34,780
In data-processing and computing services	305	3,633	44	869	4,854

SOURCE: *Ekonomika i zhizn,* No. 41, October 1994, p. 1.

Table 6

Number of Small Enterprises in the Russian Federation

	1991	1992	1993	1994[a]
All enterprises	268,000	560,000	865,000	1,038,000
Scientific and scientific services	10,600	35,900	64,800	90,000

[a]Preliminary estimate.

SOURCE: *Ekonomika i zhizn,* No. 7, February 1995, p. 1.

This discrepancy may reflect the growth of small enterprises over a 12-month period (assuming that Table 6 presents the statistics for December 1994). In addition, however, the fact that the lower statistics appear in an article that is distinctly negative about the future of small business and the state's ability to support it,[43] as distinct from the positive spin of the February report, raises the issue of whether statistics have generated conclusions or vice versa.

The experts disagree not only on the number of small S&T firms, but on their viability. One report declares that all its statistics confirm

[43]The negative views belong to I. Grachev, chairman of the Subcommittee on Small Business of the Committee on Property, Privatization, and Economic Activity of the RF State Duma, interviewed by I. Sklyarov in *Ekonomika i zhizn,* No. 41, October 1994.

the profitability and efficiency of small business,[44] while another states definitively that "as a rule, small-scale entrepreneurship loses out with respect to the efficiency index."[45]

An October 1994 report on "small and medium businesses" perceives an overall state of stagnation in the sector, declaring that 90 percent of its enterprises, "regardless of their declared sphere of operation, are surviving only on trade and intermediary business."[46] Scientific enterprises are singled out as especially unpromising:

> Highly technical small businesses are coming to grief almost everywhere in Russia, and this is not only an enormous loss for the economy, but represents incorrectable moral and technological damage. It looks as if Engineer Zabelin will again be forced to sell matches.[47]

But the latest government figures put employment in small enterprises at about 9.4 million and production at 12 to 14 percent of total industrial output in 1995.[48] Another report speaks of a "boom in creating small enterprises within institutes and independent private firms with an emphasis on scientific production."[49] A survey of St. Petersburg gives the number of scientific research and development firms as 12 percent of all small firms and presents a picture of dynamic development:

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[44]Valeriy Cherednichenko, "The Prosperity of the Regions Depends on Development of Small and Medium-Sized Business," *Izvestiya (Finansovyye izvestiya supplement)*, No. 28, April 20, 1995, p. 16. Cherednichenko is the deputy director of the Center for Social Forecasting and Marketing.

[45]V. Fyodorov and A. Tsygichko, "Having Destroyed Large-Scale Production, We Shall Finish Off Small Business As Well," *Ekonomika i zhizn*, No. 18, May 1995, p. 1. Fyodorov is the vice president of the Russian Union of Industrialists and Entrepreneurs and Tsygichko is a doctor of economic sciences.

[46]Vladimir Pripisnov and Alexander Chepurenko, "Small Business: The Onset of Crisis," *Delovoy mir*, October 10–16, 1994, pp. 24–25.

[47]Ibid.

[48]These figures were given by First Deputy Economy Minister Andrei Shapovalyants, ITAR-TASS, August 17, 1995.

[49]Olga Bausk, "The Departure of Personnel from Academy and Branch Science in Russia: Stimuli and Counterbalances," *Occasional Papers of the Georgetown University Russian Area Studies Program*, No. 6, September 1994.

> In St. Petersburg science, small business firms already constitute 10 percent of the Russian total. This sector of the economy is growing rapidly.[50]

This picture is fleshed out somewhat by V. Blaukhman's 1993 study of small enterprises in St. Petersburg. The author reports that a number of large R&D institutes founded small enterprises, registering them as joint stock companies or partnerships (*tovarishchevsta*) with limited responsibility. He offers the example of the Russian Institute of Power Radiobuilding (which carries out R&D and production of instruments for radio communications systems at all wavelengths), which has a share in the basic capital of 20 joint stock companies. The relationship between parent institute and spinoff is designed to be mutually beneficial: What the small firms take from the major institutes in the form of intellectual property, personnel, and material facilities, they presumably return in the form of foreign currency. Blaukhman's limited survey revealed three distinct types: (1) 30 percent of firms were primarily involved with innovative activity (R&D, introducing developments); (2) 50 percent combined innovative activity with the rendering of a variety of services (middleman, commercial, consulting, training cadres, servicing new technology); and (3) 20 percent combined R&D with the production of high-tech goods. About four-fifths of St. Petersburg's small S&T enterprises, in order to lower risks and increase profits, combined R&D with (mostly software-related) commercial activity.[51] While recognizing the "parasitic" elements of the small enterprises, Blaukhman is generally positive about their stimulating effect on the S&T community.

The wide discrepancies in evaluations of small S&T firms may, in part, be explained by their diversity: predominantly private (as Table 5 indicates), some are self-generating entities, while others were formed as spinoffs from a parent institute. Given their diversity in technological field, type and scale of operations, financial arrange-

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[50]Yelena Druzhinina, "Seventy-Nine Percent of Entrepreneurs Have Higher Education," *Delovoy mir,* January 21, 1995, p. 4. This article reports the results of a survey of the private sector and economy of St. Petersburg, conducted by the Leontyev Center under the auspices of an International Bank for Reconstruction and Development program.

[51]V. Blaukhman, "A Study of St. Petersburg's Scientific-Technical Organizations," unpublished manuscript, 1994.

ments, and form of ownership, one would expect a broad spectrum of "success to failure" in this sector.

Thus, the splintering of two giants in defense R&D into small enterprises had distinctly different results: The Almaz Central Design Bureau was broken up into 30 state and small enterprises, since "the leadership hoped that in this way, in small fragments, it would be possible to keep afloat." But, according to the chief of the central design bureau, "This straw of salvation soon snapped.... Far from everyone managed to stay alive." With half of its 12,000 staffers gone and its experimental production facility which employed 3,000 idled, the design bureau is looking for government subsidies to keep it operating. Unfortunately, nothing in the printed account indicates the causes for failure.[52] (Whether in fact the jettisoning of 50 percent of its personnel might not be a positive step in assuring Almaz's viability was clearly not considered by the director, who continues to think in terms of "everyone's" survival.)

A brighter picture—one of qualified success—is suggested by accounts of Arzamas-16's VNIIEF, the giant nuclear physics institute employing 24,000, where 41 small commercial institutes were spun off "in an attempt to keep qualified scientific cadres." Although reporting here, too, is insufficient to judge the success of the spinoffs, according to VNIIEF director Belugin, "Audits revealed that most of the small enterprises work for the benefit of the institute," acting as either a customer or a supplier for institute business. Belugin perceived the spinoffs as mechanisms for creating work and thereby preserving cadres: since "no one wants to work with the debt-ridden state enterprises," the small enterprises are more successful in attracting resources that benefit the projects of institute managers.[53]

A clear-cut success story was recently reported in which Protsessor, a failing Voronezh minicomputer plant, was "put on its feet" by forming a partnership with the IV+K firm, a private research institute formed by a small group of staffers at a defense research institute,

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[52]*Pravda*, May 6, 1995, p. 2.

[53]Zisk, op. cit., p. 73.

which develops and introduces new technologies.[54] Unable to compete with IBM, Protsessor had sharply curtailed its output, lost half of its staff, and switched to the production of automated telephone stations for railroad telephone networks—only to find that orders for its products were "insufficient." When its director noticed an *Izvestiya* article about IV+K's development of a fundamentally new technique for purifying liquids with the help of membranes, he became interested, believing the market niche for membrane filters was vast. The problem of investment capital was "improbably" solved by the private S&T group, which had accumulated funds from the sale of output manufactured at a small experimental factory and was thus able to fund the new production at Protsessor. The Protsessor–IV+K partnership is no doubt more the exception than the rule in an arena in which the absence of investment capital is high on the list of major obstacles to success. One is tempted to say that most "success stories" appear to be unique, while the failures have much in common. But this half-truth only points to the need for future research to seek out the common elements in successful ventures. My guess is that, after financing, having a reliable foreign partner adept in Western business practices will be high on the list.

Until we have detailed, objective research on small S&T firms, with breakdowns by technological fields and descriptions of their modus operandi, customers, and financial statements, individual cases such as those given above can only suggest the potential of these flexible, independent operations. However, the growth in small S&T firms within a 12-month period indicated by Tables 5 and 6, even if exaggerated by a factor of two, is still impressive. The fact that this growth occurred through grass-roots efforts, within the context of an extremely tight (private and state) capital market, and within the context of a growing small business sector, indicates that a new, vibrant R&D/S&T sector may be emerging.

However private S&T firms evolve, their long-term influence may turn out to be greater than their relatively small number suggests. For they are playing a vital role in the growth of a commercial R&D sector by serving as laboratories for the development of Western

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[54]Valeriy Mirolevich, "Private NII Helps Factory Stand on Its Own Feet," *Izvestiya*, May 4, 1995, p. 2.

styles of business management. A study carried out by the economics faculty of Moscow State University focused on the degree of "receptivity to economic stimuli" in 150 managers of about 30 Academy and branch institutes and small S&T state and private enterprises.[55] Table 7, which shows the percentages of managers who apply predominantly economic criteria in given decisionmaking arenas, indicates that small scientific enterprises are in the vanguard of "economically oriented" management, with branch science institutes coming in a respectable second and RAN institutes lagging significantly behind. The study authors point out that this outcome is related to two important factors:

- The age of the managers. At Academy institutes, only 12.5 percent of managers at all levels were younger than 35, 31.3 percent were from 36 to 50, and 56.2 percent were older than 50. At branch institutes, these percentages were 34.9, 55.4, and 9.7 percent respectively. And at small scientific enterprises, they were 94.6, 5.4, and 0 percent respectively.
- The percentage of budget funding for scientific research work. In the Academy it was greater than the percentage of contract work in 81 percent of cases and less in 19 percent of cases. At branch institutes, the ratio was reversed: 28 and 52 percent, respectively; 20 percent of branch institutes had no budget funding at all. In the small scientific enterprises, only 3 percent had any budget funding "and in amounts less than agreed upon," so that virtually 100 percent supported themselves predominantly through contract work.

These results suggest the dichotomous infrastructure in Russian science today: one side is epitomized by the Academy, with its aging leadership, traditionally oriented toward budget funding and unsuited for market conditions; the other side is the increasingly privatized sector, "orphaned by the budget," headed by younger men, and focused on survival through commercial activities. This picture must be qualified, however, by recognition of its fluidity: as budget fund-

[55]The research was carried out by the Laboratory for Economic Methods for the Management of Social Production. See Vitaliy Tambovtsev, "Ready for the Market? Economic Methods for Science Management," *Poisk,* August 26–September 2, 1994, p. 4. Professor Tambovtsev is the laboratory head.

Table 7

Percentages of Scientific Managers Employing an Economically Oriented Style of Decisionmaking

Type of Scientific Research Organization	Institute of Russian Academy of Sciences	Branch Institute	Small Scientific Enterprise
Work activity	0.0	6.5	7.7
Investment activity	14.3	38.7	46.2
Entrepreneurial and management activity	14.3	45.2	69.2

SOURCE: Vitaliy Tambovtsev, "Ready for the Market? Economic Methods for Science Management," *Poisk*, August 26–September 2, 1994, p. 4.

ing grows smaller and less reliable, the "traditional" Academy and, I would add, VUZy institutes are seeking untraditional methods of financing and management. These include:

- creation of technoparks and technopolises;
- formation of technical joint ventures;
- aggressive marketing of R&D abroad; and
- participation in the growing number of "financial-industrial groups," the controversial new superorganizations currently touted by the government as the best hope for scientific-industrial integration.[56]

While each of these developments has its special opportunities and challenges, the obstacle common to them all is the inadequacy of both domestic and foreign investment.

[56]The formation of financial-industrial groups (FIGs) is a phenomenon to be watched, as it has intriguing possibilities for both the defense industry and the economy as a whole. FIGs—conglomerates of weapons designers, producers, banks, and insurance and investment companies—are at the center of President Yeltsin's latest plan to restructure the VPK. On August 25, a Yeltsin aide announced that two or three military FIGs would be formed in 1995; one would consist of 20 to 35 aviation enterprises and five banks and would involve the principal designers and producers of MiG-29 fighters. Open Media Research Institute Daily Digest, August 28, 1995, as reported by INTERFAX on August 25.

The Investment Factor. Of the three most likely potential investors in Russian science—the Russian state, Russian business, and the West—the latter two are almost certainly the most likely candidates for providing the kind of substantial, long-term investments that Russia's increasingly privatized S&T sector must have if it is to survive.

The federal government's continuing inability to implement budget allocations, discussed at some length above, is a clear indicator of its poor potential as an investor, setting aside the question of whether there is a strong, unified political will to strengthen R&D. Critics of the government's 1995 Federal Program of Investment are already declaring it in deep trouble, since "the government has not paid out a single ruble in the framework of the '1+4' scheme of state-private financing of investment projects."[57] Moreover, of the applications approved for investment, none were in the areas of R&D or advanced technologies.

Where the government *can* be effectual is in the passage and implementation of legislation that offers incentives and protections to both domestic and foreign investment. Yet Prime Minister Chernomyrdin, at a May 25 cabinet meeting, reportedly rejected proposals to encourage domestic and foreign investments in the period 1995 to 1997, despite Labor Minister Gennady Melikyan's report that investment in industry during the first four months of 1995 was down 35 percent compared to the same period in 1994.[58] In August, Deputy Economics Minister Vladimir Kossov singled out vague and contradictory legislation as a primary obstacle to encouraging foreign investment and noted that the Duma was attempting to pass legislation to make foreign investment more attractive. Citing the discouraging influence of Russia's political uncertainty, he predicted that foreign investments for 1996 will remain in this year's range of $1.2–1.5 billion.[59]

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[57]Vladislav Borodulin, "The Government's Investment Policy," *Kommersant-Daily,* May 6, 1995, p. 2.

[58]Open Media Research Institute Daily Digest, May 26, 1995. Melikyan added that overall investment in 1994 was down 26 percent compared to 1993.

[59]INTERFAX, August 11, reported in Open Media Research Institute Daily Digest, August 14, 1995.

This said, the continuing, long-range role of foreign investment and joint ventures in Russia's technological development should not be underestimated. While a full discussion of this phenomenon lies outside the scope of this study, the following short list of recent developments gives some indication of its range and potential.

- The European Bank for Reconstruction and Development (EBRD) has established a regional venture fund in Yekaterinburg that plans to invest $30 million in the charter capital of small and medium-sized industrial enterprises.[60] It is a safe bet that a large number of the recipient firms, in this heavily military-industrial region, will be technology oriented.
- A $190 million deal to develop and launch the first module of a new international space station was signed by Russia's Khrunichev Space Center and the U.S. Boeing Defense and Space Group on August 15. The module will be the first component of what is expected to be the $30 billion Alpha space station, the first international high-tech orbital laboratory.[61]
- A recently announced South Korean joint venture between Samsung Electronic and Russia's Crosna will produce electronic switching systems and cellular communications networks in Moscow. Within a year of its December startup, the company expects to turn out telecommunications systems with the capacity to accommodate 500,000 subscribers annually.[62]

Thus, whatever the immediate political and economic obstacles to foreign investment in Russian technology, it seems clear, to this analyst at least, that the vast monetary and scientific resources of the industrially developed nations, as well as their advanced financial infrastructures and economic self-interest, represent the long-term solution to Russia's technological advancement.

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[60]The venture will invest in enterprises in Sverdlovsk, Chelyabinsk, and Perm regions over a ten-year period. Open Media Research Institute Daily Digest, September 1, 1995.

[61]Open Media Research Institute Daily Digest, August 16, 1995.

[62]Monitor news service, September 15, 1995.

Next to this foreign potential, domestic resources pale. Russian regional and local governments, to which the state has attempted to transfer responsibility for supporting R&D organizations located within their geographical jurisdiction, have extremely limited means, and their interests are focused quite logically on scientific projects with immediate local applications.

As for investments of Russian business/industrial capital in S&T, the common wisdom of the scientific community has been that there is little to be expected from that quarter. Scientists have argued that (1) private business, at its current "primitive" state of operation, has no need of advanced science; (2) manufacturing firms as well as big state and privatized firms have no money; and (3) in the present economic crisis, no large enterprise "would even think of financing R&D. They won't give anything even to applied science in the near future. Maybe later, when competition emerges. But they'll never spend a penny on basic research."[63] A dissenting view is given by Bausk, who sees potential in such business clubs as Tverskoy Bulvar in Moscow or the business club of Novosibirsk, which are designed to establish contacts between representatives of business and science. Although the projects supported by such clubs are few in number, Bausk sees them as the first signs that "nongovernmental businesses are beginning to remember the needs and demands of science." The fact that many new entrepreneurs formerly had scientific careers, she believes, gives reason to expect that "they have retained their respect for intellectual activity and an understanding of [Russian science's present] difficulties."[64]

While the validity of this hopeful scenario remains to be demonstrated, a recent development—the $1.5 million commitment by Logovaz Bank, reported above, to send scientists to international conferences—points to a potential increase in Russian investment in S&T over the long term. According to First Deputy Premier Chubais, "as the Russian economy improves," more Russians are bringing money back from abroad to participate in its growth. In 1994, Russian money accounted for only 10 to 15 percent of investments in the

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[63]Bzhilianskaya and Kosals, op. cit.

[64]Bausk, op. cit., p. 21.

country; now it accounts for 50 to 60 percent, said Chubais.[65] At a recent international conference, "Russian Enterprises in Search of Investment," one of the central themes was "the search for ways to attract Russian capital into investment projects," including the creation in Russia of shareholder investment funds and investor trust funds.[66] Thus, while the long-term potential for Russian investment should by no means be ruled out, especially if Chubais's statistics are accurate, what this would mean for the S&T sector remains unclear.

What *is* clear in upbeat pronouncements on the growth of domestic investment is increasing nationalistic resentment of Western investment. Chubais declared that Russian investments would allow Moscow to "force the dollar out of all sectors of the Russian economy." A recent Duma report expressed concern over the "worrisome trend" of foreign investment in Russian defense industries.[67] At the more extreme end of the political spectrum, Vladimir Zhirinovsky proposed expelling foreign groups like the Soros Foundation and the Carnegie Endowment.[68]

Such protectionist and xenophobic sentiments, while far from universal, have grown increasingly widespread in recent months and are not likely to increase the confidence level of potential Western investors. As matters stand, the current level of foreign investment is not high—about $3 billion since the end of the Soviet Union, that is, less than a billion a year "for a country with enormous economic possibilities and a population of 150 million."[69] Finance Ministry officials report that, due to the fighting in Chechnya, there was no increase in foreign investment in Russia during the first quarter of

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[65]Monitor news service, June 12, 1995, citing an INTERFAX report.

[66]Konstantin Levin, "Russian and Foreign Investors Are Twin Brothers," *Kommersant-Daily*, May 13, 1995, p. 2.

[67]Monitor news service, June 14, 1995, citing a report in *Birzhevskiye vedemosti* (No. 23). GKOOP participated in the preparation of the report, which noted, as examples, that two U.S. firms hold more than 54 percent of the stock in the Avrora electronics plant and German firms own 20 percent of the Kaluga shipyards.

[68]Monitor news service, June 28, 1995, citing a June 27 *Pravda* interview with the Russian nationalist leader.

[69]Monitor news service, June 9, 1995, citing a study by the Infomart agency reported in *Birzheskiye vedemosti* (No. 23).

1995.[70] A U.S. Chamber of Commerce estimate puts the overall foreign investment at $2 billion at the end of last year, with another $500 million invested between January and May 1995, and names the United States as the largest single investor.[71] Yet another set of statistics, compiled by GOSKOMSTAT, puts the total foreign investment for 1994 at $1.05 billion and 89 billion rubles.[72] The GOSKOMSTAT report is of special interest, since it gives the dollar amount invested in "research and research services" in 1994 ($25,900,000) and its percentage of the total investment (2.5 percent) for that year. Equally interesting is the report's observation that "research and research services are among the dozen most attractive branches of the economy for Western investors" and its subsequent commentary:

> This may be regarded as a positive feature, yet it simultaneously puts us on our guard, since in exchange for relatively small investments, which, on the whole, make no great waves, a foreign investor frequently gains access to national scientific developments, which with their skillful use, will bring him sizable profits.[73]

A similar divided mind-set has been expressed by managers of Russian R&D organizations, who resent selling their technologies cheaply yet feel a grudging gratitude for the foreign monies that allow them to go on operating. The testimony of the director of the Pulsar firm, which produced semiconductors for 35 years, working mainly for the military, is worth quoting at length:

> Our firm is now working with leading firms in the U.S., Italy, and China on the very newest deals in radio communications. But they deal with us only if our developments are world level, while our prices are considerably lower than what they'd have to pay to oth-

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[70] *Izvestiya* (*Finansovyye izvestiya* supplement), June 27. According to Finance Minister Panskov, as told to INTERFAX, June 29, the activity of Russian banks that fear competition is another barrier to foreign investment.

[71] Open Media Research Institute Daily Digest, June 28, 1995. The report names the next-largest investors as Germany, Austria, and Finland.

[72] Yelena Fedorova, "Half of All the Foreign Investments in 1994 Were Shared by Five Firms," *Izvestiya* (*Finansovyye izvestiya* supplement), No. 26, April 14, 1995, p. 2. Fedorova is with the State Committee for Statistics.

[73] Ibid.

> ers. And since our government doesn't support experimental research, we have to put up with this. We can only pay salaries with what we earn, not support new research or buy new equipment. In other words, we've sold our brains—to foreigners.[74]

What is striking about Pulsar's situation is that it is a best-case scenario: the great majority of R&D firms, which do *not* possess world-level developments of interest to foreign investors, have not been given Pulsar's highly desirable option of selling their brains to foreigners. What the director's words make clear is that unless the Russian government creates other possibilities, high-level R&D firms, whatever their professional discontents and patriotic fervor, will continue to take the "foreign option." In time, some may even earn enough to finance new R&D.

Should this be the case, i.e., if Russian R&D institutes survive and prosper through foreign investment and in time develop a robust commercial R&D sector, would this sector be responsive to the needs of the Russian military? Or would it, as seems more likely, draw resources away from defense-related research? Clearly, there would have to be huge economic incentives for independent, profit-oriented S&T firms to participate in military business. At present, however, with foreign investment in R&D still small and much of the S&T sector still floundering, the Russian government, theoretically at least, has not exhausted its options for enlisting these vital scientific resources for national security ends. What the government hopes to achieve in technology development and how it hopes to do so are spelled out in the latest S&T policy documents.

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[74]Yuriy Dokuchayev, "To Defend Those Who Defend Us," *Inzhenernaya gazeta,* No. 32 (639), March 1995, pp. 1–2. Dokuchayev is the director of the Pulsar NII.

Chapter Four

DEVELOPING ADVANCED R&D: ENDS VERSUS MEANS

NEW S&T POLICY INITIATIVES

The spring of 1995 brought a fresh influx of policy documents on science and technology from every sector of the defense and civilian science establishment. The impetus for this latest spate of planning initiatives was twofold:

- The ongoing war in Chechnya, which continued to display the shortfalls of current defense readiness and to demonstrate the need for weapons upgrading and modernization.
- The intensifying crisis in civil science, underscored by the failure of the 1995 federal budget to satisfy the demands of the scientific community for increased allocations.

In early March, both the Ministry of Defense, represented by Andrey Kokoshin, and the Russian Security Council's Interdepartmental Commission for Research and Development in the Defense Industry came forward with mutually supportive programs (discussed on pages 22–23) for developing advanced weapons and technologies and protecting Russian weapons designs abroad.

Kokoshin's complaint of government unresponsiveness to Ministry of Defense proposals coincided with the publication of both an edict on the establishment of the RF President's Council for Scientific and Technical Policy[1] and the statute that defines this council's rights

[1] *Rossiyskaya gazeta,* March 11, 1995, p. 5.

and duties and lists its large, eminent membership.[2] The council is primarily designed "as a consultative body established to inform the RF president about the state of affairs in the realm of science and technology and to develop proposals on the most important issues of scientific and technical policy in the country." One of the goals of such a council is to eliminate the redundancy in S&T policy proposals with which the embattled science, defense, and industrial leadership has been bombarding the government.[3] Given the splintering and contentiousness of Russian public life, whether the 25-member council will indeed be a forum for coordination or for dissent remains to be seen.

The council for S&T policy was given a double message at its initial meeting on May 25, when President Yeltsin, walking the fine line between asserting the government's role in helping science and recognizing its relative impotence to do so, both promised to increase state funding for science in the 1996 budget[4] and urged scientists to look to the private sector rather than the government for aid![5] More "doublethink" was in evidence when Yeltsin called for developing strong international contacts "but with a clear understanding of the need to defend Russia's national interests."[6]

By mid-August, however, President Yeltsin, addressing the council, announced the drafting of a new program on dual-purpose tech-

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[2]Appendix D lists the council's membership.

[3]Deputy Minister of Science Andrey Fonotov made clear that this was indeed a primary incentive for creating the Council:

> Today, several ministries, including ours, MinAtom, the GKOOP, and the Ministry of Fuel and Energy, are independently developing scientific-technical policies. It is essential to coordinate this activity, to bring the interested parties together for the solution of common problems. We are now able to do this: on February 1, Victor Chernomyrdin, having accepted our requests, signed a document creating a government commission on scientific-technical policy.

Poisk, No. 6 (680), February 4–10, 1995, p. 1.

[4]*Rossiyskaya gazeta,* May 25, as reported by Open Media Research Institute Daily Digest, May 25, 1995.

[5]*Podmoskovskiye izvestiya,* May 25, as reported by Monitor news service, May 25, 1995.

[6]Ibid.

nologies, as well as his intention to raise the funding for R&D in the 1996 federal budget from 3 trillion to 9.5 trillion rubles. Yeltsin stressed Russia's "colossal potential for a powerful technological breakthrough in the field of conversion" of military technologies with commercial applications.[7] Within a month came the announcement of an 18.6 trillion ruble ($4.2 billion) plan to subsidize conversion of defense plants to civilian production. Although the failure of previous state conversion plans dictates a heavy measure of skepticism in anticipating this one, as the latest attempt to inject sizable conversion funding into the defense industry, it bears close watching. While political considerations almost certainly played a role in this election-year initiative, it may also represent a firmer government commitment to reallocating resources to civilian technology development.[8]

While the president's S&T council was being organized, a comprehensive program, Decree No. 3360 of the Russian Federation government: "On State Support for the Development of Science and Scientific and Technical Developments,"[9] was developed in conjunction with the Russian Academy of Sciences and the Ministry of Science. On April 17 Premier Chernomyrdin signed the decree, whose resolutions grew out of a government conference on the problems of science, in which RAN and MinSci reportedly minimized their long-time differences in the interests of their mutual cause.[10] The major points of what should probably be viewed as the latest official version of state science policy are as follows:

- Allocate special funds to wipe out government debts to scientific organizations, including federal science centers.

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[7]Open Media Research Institute Daily Digest, August 17, 1995.

[8]The plan was approved by the RF Commission for Operational Questions, according to ITAR-TASS, September 19. The federal budget is expected to provide 7.3 trillion rubles, while the remainder will come from "special credits and other sources." Claiming that conversion programs had saved 650,000 jobs and generated 3.9 trillion rubles of civilian production in 1992–1994, Deputy Economics Minister Yakov Urinson proposed that the new conversion program be placed in an off-budget fund, presumably to defend it against Finance Ministry cuts. Open Media Research Institute Daily Digest, September 20, 1995.

[9]*Rossiyskaya gazeta,* April 26, 1995.

[10]"Forward—Along an Ascending Path?" *Poisk,* No. 9 (303), February 25–March 3, 1995, p. 1.

- Allocate foreign currency to support patenting and certification of domestic technical developments abroad.
- Allocate foreign currency for purchase of scientific equipment, journals, and dues for international scientific organizations.
- Examine the possibility of increasing construction of "social facilities," in the second quarter of 1995, using both local and federal funds.
- Approve a plan of measures for 1996 for financing civil R&D, to be not less than 3 percent of the federal budget, with subsequent increases.
- Institute tax exemptions for import and export of scientific materials and equipment.
- Prepare proposals for targeted support for leading scientific schools and submit them to the government in the second quarter of 1995.
- Formulate and implement measures to support development of science and innovative activities in the regions.

In addition, with the goal of restructuring the S&T sphere in 1995, ministries and departments are instructed to analyze the network of both state and private science organizations and determine their organizational-legal form and basic activities. The results are to be presented to MinSci.

Finally, the president's council for S&T policy must ratify top-priority avenues of S&T development, as well as list critical federal-level technologies.

The above resolutions are accompanied by a detailed plan for carrying out the program in 1995, specifying what measures are to be carried out, within what time period, and by whom.[11]

This program, painstakingly worked out by the leaderships of MinSci and RAN, appears, in virtually every aspect, to offer a reasonable blueprint for relieving the current crisis, setting a course toward rational downsizing of the scientific infrastructure, and focusing lim-

[11]This plan is reproduced in Appendix E.

ited funds on key technologies. As concrete proof that the science community has at last gotten the government's attention and enlisted its support, it represents a preliminary victory and holds out the hope that science will once more be treated as a "priority direction." What causes uneasiness, however, is the number of items containing the phrase "allocate special funds" or "allocate foreign currency." No sooner was the decree published than "fears were being expressed in the scientific world"[12] that the decree will not be carried out. The consistent pattern of broken promises with respect to government allotments for science gave rise to doubts which, to date, have been more than justified by the government's poor performance in implementing its 1995 science/defense/education budgets. However, there are a number of items whose fulfillment does not immediately depend upon fund allocation—such as streamlining the S&T infrastructure, instituting tax exemptions for import and export of scientific materials, and designating priority technologies and leading scientific schools for targeted programs. Implementation of even some of these policies, particularly the replacement of across-the-board miserly funding by adequate funding of a few key programs, would be a major turning point for a sector that until now has been more or less randomly self-destructing.

Yet another initiative, which looks like an attempt to preempt the presidential S&T council in the selection of key technologies, is the "National Technology Base."[13] This was a draft of a new federal program put forth by the GKOOP S&T Council on April 25, for discussion with representatives of the Ministry of Defense, MinAtom, the Russian Committee for Machine-Building, the Russian Space Agency, RAN, MinSci, and others. The heart of this program is a strategy for preserving and developing the technological base by carrying out "comprehensive R&D on base technologies of critical import," including:

- information technologies
- technologies based on new materials

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[12]Vsevolod Medvedov, "Urgent Assistance for Science," *Rossiyskaya gazeta,* April 26, 1995, p. 5. Medvedov is a RAN corresponding member.

[13]Alexander Yegorov, "National Technology Base," *Krasnaya zvezda,* April 29, 1995, p. 4.

- microelectronics
- nanoelectronics
- optical electronics
- laser and radioelectronic technologies
- power generation and energy saving
- advanced engines
- highly productive industrial equipment
- special chemicals
- energy-intensive materials
- unique nuclear technologies
- biotechnologies
- environmentally safe technologies.

The program aims to overcome Russia's "dangerous" technology lag; to create conditions for the development of competitive science-intensive output in the sphere of modern technology systems (air, sea, and ground transport, communications and utility systems, space technology and medical equipment); and to create a scientific and technical basis for "radical change in the export structure toward a science-intensive end product . . . ."[14]

Once more, we are presented with a program whose ends cannot be faulted, though the existence of sufficient means to accomplish them is extremely dubious. The GKOOP authors of this plan want to fund their highly ambitious and costly program through "reallocating funds in various sections of the budget and extrabudgetary funds." They believe that about 1.5 trillion rubles could be allocated for the program this year, including 1.15 trillion in federal budget funds. In the future, the National Technology Base would attain the status of a presidential program with its own funding section in the federal budget. The announcement of these two major plans—one sponsored by the leading proponents of civil science, the other by the representatives of defense technology—demonstrates that the Russian

[14]Ibid.

government is aware of the extent of its science and technology crisis, advanced in its notions of what directions must be pursued, and determined to do something about it. Whether it has a realistic strategy for obtaining its ends is another question. Given the overall shortfall of federal funding in 1995 and the number of hungry contenders for what is left of the budget pie, the notion of "budget reallocations" to fund the national technology base appears unrealistic in the extreme. As for the statute on government support for the development of science, most of its designated tasks for 1995 consist of coming up with proposals for carrying out the overall program goals. While such a measured approach doubtless has its merits, it contains the inherent danger that existing scientific resources will be lost faster than new ones can be created.

ENDANGERED RESOURCES

Of the two categories of loss besetting the Russian S&T community, one material (decaying capital assets, outmoded and unreplaced equipment and instrumentation), the other human (diminishing scientific cadres), it is surely the latter that presents the greatest long-term threat to Russia's future as a world-class scientific power. With the requisite funds, buildings can be renovated or replaced and laboratories refurbished with state-of-the-art equipment. Replacing scientists who have left for other professions or other shores and compensating for a potential "missing generation of scientists" is far more problematic, since countries that want to remain in the technological vanguard absolutely must maintain a continuous tradition of scientific excellence.

There are two aspects to the loss of scientific cadres: (1) the much-debated brain drain; and (2) the less-discussed issue of what one research team has called "a serious breach in the reproduction mechanism" of the scientific community.[15]

As for the brain drain, despite the occasional claim that the situation is "stabilizing," there is a general consensus on the intensification of this process. A May 5, 1995 report in *Kuranty* declared that "the youngest and most talented scientists are abandoning the research

[15]Bzhilianskaya and Kosals, op. cit., p. 13.

sector" and supported its contention with the following statistics: Between 1990 and 1993, the number of scientists fell by 1.2 million—almost one-third. Most go into business (the internal brain drain), where wages are substantially higher, while a smaller but still significant number go abroad (the external brain drain). The report said that 34,000 scientists had emigrated over the past six years, mostly to Israel, Germany, and the United States. Although no data were available on the number working abroad on temporary contracts, it was judged "likely to be higher."[16] Further evidence of the scope of the brain drain is provided by MinSci statistics, which show that 70 to 80 percent of Russian mathematicians have gone abroad, with the theoretical physicists not far behind them.[17] Since only the best scientists are offered positions abroad, the loss to Russian science is one of quality as well as quantity.

As for the future course of the brain drain, most analysts agree with the common-sense conclusion that it can be staunched only by an improvement in scientists' working conditions—including higher wages and reestablishment of conditions suitable for conducting research. Although the Soros Foundation, as noted above, has succeeded in creating these conditions for a substantial number of top scientists, its operations are currently contracting, while the effectiveness of successor organizations, which may choose to borrow the Soros infrastructure, remains unknown. For the majority of Russia's scientists, no improvement of their lot appears to be on the horizon, and there is widespread expectation that many scientific institutes will be closed shortly for lack of funding, with substantial losses of qualified workers.[18]

It would be misleading, however, to view the brain drain as more or less unreconstructed state planners do, as a wholly negative phenomenon. The foreign sojourns of Russian scientists, which expand their horizons and result in important international contacts, often bring positive feedback to their home institutions, especially if the

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[16]As reported in Open Media Research Institute Daily Digest, May 10, 1995.

[17]Pokrovskiy, op. cit.

[18]See, for example, Bzhilianskaya and Kosals, op. cit., p. 19, and *Poisk,* No. 6 (300), February 4–10, 1995, p. 2, which speaks of "the beginning of a period of forced liquidations of Academy scientific institutions and mass firing of workers."

scientists return to Russia either permanently or periodically. The internal brain drain, too, is far from an unmitigated evil. Many who choose business over science might have done so in the past, had the opportunity been available. And the existence of capable, scientifically trained individuals entering the business sphere, in light of the vital importance of building up science as the main driver of Russian prosperity, can only be viewed as an advantage.

As for the failing "reproduction mechanism" for scientists, i.e., the system of higher education, it has generally been described as deteriorating, along with the rest of the scientific infrastructure. With scientific prestige and scientific salaries way down, VUZy enrollment has been dropping steadily (although not dramatically) for a number of years. Table 8 indicates this decrease in the number of students, particularly of graduate students, between 1985 and 1993, despite the increase in the number of institutions.

Other research indicates an opposite trend. For two consecutive years, competition for entrance to the VUZy has grown: in 1993, by 4 percent, and in 1994, by 10 percent. The greatest competition was not, however, for entrance to the scientific or technical VUZy and, as the authors themselves note, "what happens in 1995 will determine whether this is a trend or a temporary upsurge."[19]

Table 8

Basic Indicators of Performance in Russia's Higher Schools

Indicators	1985/86	1990/91	1991/92	1992/93
Number of institutions	494	502	519	535
Students				
Enrollments	2,966,000	2,824,000	2,763,000	2,638,000
Undergraduates	476,600	401,100	406,700	425,300
Graduate students	(no data)	39,115	37,731	36,747

SOURCE: Valery N. Lenshin, Occasional Papers of the Georgetown University Russian Area Studies Program, Number Eight, September 1994, p. 4. Modified from Table 1, "Higher Schools Under the Pressure of Radical Reforms."

[19]"Competition to Enter Russia's VUZy Has Grown," *Poisk*, No. 1–2 (295–296), January 7–13, 1995, p. 13.

Whatever the enrollment trend, statistics have been published showing that 80 percent of students at Russia's higher technical schools have no intention of working in their chosen field: they will either go abroad or go into business.[20] The difficulty of universities and institutes in finding employment for their graduates, "aggravated by the perceived decline in the need for specialized knowledge," doubtless contributes significantly to this "defection."[21] A study of VUZy in seven Russian cities, commenting on the brain drain abroad, concludes that

> if the amount of student and teacher migration is not so great, the quality of those who leave is high: as a rule those with the most initiative, energy and talent leave.[22]

The same survey reports that 74 percent of students in technical and scientific VUZy did not participate in VUZy scientific work. Seventy percent expressed the belief that conditions for such work had worsened in the previous three years and did not believe things would soon change for the better. Not surprisingly, half of the respondents were thinking of quitting. With graduate students providing a large percentage of future VUZy researchers, reduction of research cadre potential for VUZy on January 1, 1994, in comparison with 1989, was more than 55 percent.[23]

After citing the "pitifully small" sums VUZy have available for basic research, the tiny salaries of researchers, the impossibility of modernizing the material base, the crisis in the computer base, and the realization that nothing would improve in 1995, GOSKOMVUZ first deputy secretary Tikhonov was asked by his interviewer how, in that case, he could claim the VUZy were surviving. His reply was in the old Soviet heroic mode: "The mentality of Russia's VUZy is this: we

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[20]Vladimir Zakharov and Vladimir Fortov, "Science Is Already in a Coma," *Izvestiya,* November 2, 1994, p. 2. Zakharov and Fortov are RAN academicians.

[21]Valery Lenshin notes: "In 1992 the universities and institutes were not able to find employment for 20 percent of their graduates and in 1993 this figure rose to 45 percent." Occasional Papers of the Georgetown University Russian Area Studies Program, Number Eight, September 1994, p. 6.

[22]V. G. Kharcheva, "Future Academicians Are Still Students," *Vestnik Rossiyskoy Akademii Nauk,* 1994, Vol. 64, No. 11, pp. 1002–1007.

[23]"In the Dark, But Not Blind, " op. cit.

always believe in a better tomorrow."[24] Others, however, faced with the same realities, find such belief difficult. An early 1994 survey of experts projected the following scenario for the progressive loss of Russia's qualified scientific personnel in the area of basic science, defining three critical points:

- **The next 2 to 3 years.** During this period, say the experts, experimental work may still survive. But if there is no qualitative improvement of work conditions for experimentalists, experimental capabilities will rapidly be degraded. (Experimentalists require laboratories equipped with sophisticated, unique hardware.)
- **The next 10 years.** During this period, it is still possible for theoretical research to be preserved.
- **The next 25 to 30 years.** This is the period of generational change, beyond which the tradition of carrying out research "will be almost entirely, and, in some cases, irrevocably lost, and will have to be restored anew. Science would have to be imported from abroad, as there would be no more cultural grounds for it."[25]

Others[26] take a less apocalyptic view: Rather than a "missing" generation of Russian scientists, they foresee a period in which young scientists will be underrepresented but not altogether absent; they could then form an essential core of teachers and researchers for the next generation of scientists. From this perspective—that what will remain is a diminished but by no means permanently disabled S&T community—it is possible to conclude that Russia will have at least some of the human resources required to carry out its ambitious S&T policies. Should this be the case, whether and to what extent it can achieve these ends will depend upon the impact of complex and multifold political factors on the setting of national priorities.

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[24]Ibid.

[25]Bzhilianskaya and Kosals, op. cit., p. 20.

[26]Including Gerson Sher, executive director of the Washington office, International Science Foundation. Personal interview.

Chapter Five

CONCLUSIONS

As this study has argued, the prospects for Russian military R&D are inextricably bound up with the evolution of the technology sector as a whole—military, civil, dual-use—which is itself hostage to an increasingly conflictual and strained sociopolitical situation. Seeing no other way out, the VPK has jumped into the political fray, forming a party of its own to lobby for its aims. Under more normal circumstances, it might prevail—just as demands for funding weapons R&D and acquisition receive high priority in the United States. But Russia's circumstances are not normal. While the experts argue over whether the economy is deteriorating, stabilizing, or improving, one-third of the people have fallen beneath the poverty line. Life spans are decreasing; the suicide rate is increasing; epidemics of "defeated" and Third World diseases are increasingly common; and the crime rate is astronomic. With some experts now estimating "real unemployment" at 18 percent,[1] as many as one out of five Russians may be looking for work in a chaotic economic environment, where the government has made wholly inadequate arrange-

[1]This figure was reported by Tatyana Maleva, an expert at the Institute of Economic Analysis, to *Segodnya* on June 30. Monitor news service, July 3, 1995. A lower estimate of 13.6 percent of the workforce, or 9.6 million people, was put forth by the Federal Employment Service on August 6. This report indicated that 5.7 million people are actively seeking work, of whom approximately 2 million are officially registered as unemployed. This figure has increased by 20 percent since the beginning of 1995. Additionally, there were said to be 3.9 million "hidden unemployed," i.e., those working reduced hours or on compulsory unpaid leave. The widespread practice of short-time work, particularly common in scientific organizations, light industry, the chemical industry, machine-building, transport, and communications, was considered a major factor preventing mass open unemployment.

ments for job counseling and retraining. As economic restructuring continues, unemployment may be expected to increase. Unreliable budget funding has delayed paychecks to military and civilian workers alike, for months at a time, while unchecked inflation has made it ever more difficult for average Russians to purchase essentials with these missing paychecks.[2]

Politically, the bloody and expensive conflict in Chechnya has only deepened the split between political factions. Every day a new political bloc declares itself, while the public remains apathetic, having lost its faith in politicians. With the most popular presidential candidate claiming all of 8 percent of the vote, the results of either presidential or Duma elections, if and when they are held, defy prediction.

Thus, like the country itself, the fate of military R&D is to a great extent out of control. Laws, programs, and policy initiatives are abundant but bear little relation to what is actually done. With high levels of social distress making primary claims on the budget, there is no reason to believe that government funding of S&T will increase substantially any time soon. New competitive funding methods, imported by Western donors, may gradually transform for the better the manner in which research funds are distributed and thereby ensure that, as the science community shrinks, many of the fittest will survive. That a good many institutes and design bureaus will *not* survive is becoming increasingly apparent.

The crying need is for investment, from both the Russian private sector and from the West. Since Western capital and technical cooperation are the Russian scientific entrepreneurs' best hopes, one would expect the RF government to pass legislation that stimulates and protects investment and all kinds of cooperative arrangements. But this strategy increasingly conflicts with a self-defeating desire to close the West out, fueled by nationalistic resentment of Russia's underdog position and a distinctly Cold War–style paranoia.

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[2]In June, the Duma refused to outlaw prostitution. On June 21, *Literaturnaya gazeta* explained why: The deputies apparently felt that (a) there should be at least one category of workers that is paid on time; and (b) there should be one category of workers that does not consider it acceptable to complain to the government, should it *not* be paid on time. Monitor news service, July 3, 1995.

In a **worst-case scenario,** xenophobic elements will triumph in the next election and scare off Western investment even before they have a chance to close it off. A highly conservative government, authoritarian and militaristic, would favor increased funding for military R&D and acquisition, but would still have to deal with urgent, resource-consuming social needs first. While such a regime might attempt to reverse the process of privatization, renationalization of scientific and industrial resources is no longer an option. Too much property is already in private hands, including the mafia's. The chaos inherent in any attempt to turn back the clock would only further cripple technology development. With Western aid diminished and budget allocations failing to take up the slack, R&D would do worse than it is doing now; the brain drain would inevitably increase.

In a **best-case scenario,** Victor Chernomyrdin, or someone of his middle-of-the-road ilk, succeeds President Yeltsin, who, perhaps for health reasons, has reluctantly decided to step down. With a less authoritarian, more compromise-prone leader, the conflict between the executive and legislative branches of government might be more amicably resolved, with division of powers defined by law and universally respected. As the process of government becomes more clearly defined, setting up realistically financed programs for developing selected key technologies would be more feasible. S&T budget funding itself, though distributed more effectually, would not increase substantially. In addition to the survivors of the three traditional scientific sectors, the embryonic commercial S&T sector would be enlisted in the interests of technology development. Xenophobia would be discouraged, while all forms of S&T cooperation with the West, including joint military R&D projects, would be encouraged.

A third option might be called **the stasis scenario.** It presumes that presidential and parliamentary elections, held before the end of 1996, result in a contentious coalition of democrats and communists, economic reformers and conservatives, real and Zhirinovskiy-style "liberals," not radically different from the one that presently exists, albeit with a new face in the president's office. Given Russia's deep political, social, economic, and philosophical divisions, this is the scenario that appears most likely. The implications of such a stasis scenario for the development of advanced technologies are not encouraging, for such a precarious "balance of forces" would tend to perpetuate the current underfunding of science. Without strong, di-

rected leadership, socioeconomic distress will persist and science will remain a "top national priority" in name alone. If the above-quoted experts are correct, continuation of the status quo will mean a serious degradation of basic experimental scientific capability within the next two years, a loss which will have a negative effect on basic theoretical, applied, and defense science as well. The vaunted "survival" of countless scientific and technical organizations may then become a hollow victory, with both quantity and quality of scientific work significantly reduced. The continuing shrinkage of the Russian S&T community will accelerate, while the segment that survives and prospers will, to a great extent, owe its well-being to an international science community with which it is increasingly integrated. Until Russia succeeds in creating its brand of market economy and achieves widespread economic prosperity, a process that could take a generation, its military will probably find itself far more dependent than it would like upon foreign S&T resources for the modernization of its weaponry.

Appendix A

1994 FEDERAL S&T PROGRAMS

Production processes in agriculture

New methods in processing branches of agricultural sector

Information technologies

Telecommunication and integrative communication systems

Informatization of Russia

Technologies and tools of microelectronics and nanoelectronics

The human genome

Priority directions in genetics

New methods of bioengineering

Means of supporting research in physico-chemistry, biology, and biotechnology

New materials

Ecologically clean energy

Resource-saving and ecologically clean processes in mining and metallurgy

Progressive technologies for fuel-energetic resources

People of Russia: revival and development

SOURCE: Irina Dezhina, *Financing Russian Science: Searching for Flexibility,* Occasional Papers of the Georgetown University Russian Area Studies Program, Number Seven, September 1994, pp. 9–11.

Development of education in Russia

Ecologically safe and resource-saving processes in chemistry and chemical technology

New principles and methods of obtaining chemical substances and materials

High-energy physics

Basic nuclear physics

Synchrotronical radiation, ray utilization

Superconductivity

Controlled thermonuclear synthesis and plasma processes

National priorities in medicine and health protection

Health of the Russian population

Developing new medicines by using chemical and biological synthesis methods

Global change of environment and climate

Safety of population and objects, taking account of the risk of natural and technical catastrophes

Research on oceans and seas, the Arctic and Antarctic

Stroyprogress (progress in construction)

Utilization of wood

Technologies, machines, and products of the future

Science-intensive technologies

High-speed ecologically clean transport

Highly effective technologies for developing the social sphere

Federal informational fund in science and technology

Russian forests

Russia's ecological safety

Development of medicines and articles for medicinal purposes, 1992–1997 (innovative program)

"Lekbiotech": developing a new generation of medicines on the basis of biotechnology and physical-chemical biotechnology (innovation program)

Development of new means for producing medicines by using raw materials from the Far East Region (innovation program)

Developing accounting technologies for enterprises in the trading and service spheres, 1992–1996 (innovation program)

Use and burial of radioactive waste and depleted nuclear materials (innovation program)

Certification and metrology (innovation program)

Development and organization of competitive industrial production

Russian engineering network of technical innovations (innovation program)

Development of basic research

Appendix B

1995 FEDERAL BUDGET APPROPRIATIONS FOR BASIC RESEARCH

Appendix 7 to the Federal Law "On the Federal Budget for 1995: Distribution of Appropriations for Basic Research from the Federal Budget for 1995."

	Amount in Rubles
Basic research	1,775,152,000,000
Of which:	
Russian Academy of Sciences	687,044,500,000
Siberian Branch of the Russian Academy of Sciences	256,900,000,000
Russian Academy of Medical Sciences	65,300,000,000
Siberian Branch of the Russian Academy of Medical Sciences	16,100,500,000
Urals Branch of the Russian Academy of Sciences	72,800,000,000
Far Eastern Branch of the Russian Academy of Sciences	95,700,000,000
Russian Academy of Education	18,700,000,000
Russian Academy of Architecture and Construction Sciences	2,900,000,000

SOURCE: *Rossiyskaya gazeta,* "Business in Russia" section, April 7, 1995, p. 4.

	Amount in Rubles
Russian Foundation for Basic Science	404,226,300,000
Total of which:	
Competitive Individual Support Fund for Leading Academic and Scientific Schools	100,000,000,000
Development of Computer Communications Networks and Data Bases for Basic Science and Education	61,530,000,000

Appendix C

1995 FEDERAL BUDGET APPROPRIATIONS FOR HIGHER EDUCATION

	Amount in Rubles
Higher Education	5,135,440,700,000
Of which:	
Targeted State Support for the Country's Leading Higher Educational Establishments	300,000,000,000
Other Institutions and Spending in the Educational Sphere of which	332,789,100,000
Measures to Carry Out the Summer Health Campaign	153,000,000,000

SOURCE: *Rossiyskaya gazeta,* April 7, 1995.

Appendix D

MEMBERSHIP OF THE RUSSIAN FEDERATION PRESIDENT'S COUNCIL FOR S&T POLICY

B. N. Yeltsin	President of the Russian Federation (chairman of the Council)
B. S. Chernomyrdin	Chairman of the Russian Federation government (deputy chairman of the Council)
N. G. Malyshev	Advisor to the Russian Federation president, director of the Center for Presidential Programs of the Russian Federation's Administrative staff (executive secretary)
Ye. N. Avrorin	Academician of the Russian Academy of Sciences (RAN), scientific director of the RF Nuclear Center and the All-Russian Research Institute of Technical Physics
Zh. I. Alferov	Vice president of RAN, chairman of the St. Petersburg Scientific Center, and director of RAN's Ioffe Institute of Applied Physics
N. A. Anfimov	Corresponding member of RAN, first deputy director of the Central Scientific Research Institute of Machine Building
Ye. P. Velikhov	Vice president of RAN, director of the Kurchatov Institute Russian Scientific Center
A. A. Gonchar	Vice president of RAN

SOURCE: *Rossiyskaya gazeta,* March 11, 1995, p. 5.

Yu. Ye. Dyakov	President of the Scientific Center Research and Production Concern
V. Ye. Kazanskiy	RAN academician, director of a laboratory at RAN's N.D. Zelinskiy Institute of Organic Physics
A. A. Makarov	Corresponding member of RAN, director of RAN's Institute of Energy Research
Yu. S. Osipov	RAN president
Z. P. Pak	General director of the Soyuz Federal Center for Dual-Use Technologies
V. M. Pashin	Corresponding member of RAN, director of the RF State Scientific Center and A. N. Krylov Central Scientific Research Institute
V. I. Pokrovskiy	President of the Russian Academy of Medical Sciences
S. P. Polovnikov	Chairman of the board and scientific director of the Kompozit Joint-Stock Company
G. A. Romanenko	President of the Russian Academy of Agricultural Sciences
A. G. Rochegov	President of the Russian Academy of Architecture and Construction Science
I. S. Silayev	President of the International Union of Machine Builders
A. S. Spirin	RAN academician, director of RAN's Protein Institute, chairman of RAN's Pushchino Scientific Center
N. I. Tolstoy	RAN academician, chairman of the board of the Russian Humanitarian Scientific Foundation
I. B. Fedorov	Rector of the N. E. Bauman Moscow State Technical University

Ye. A. Fedosov	RAN academician, director of the Scientific Research Institute of Aviation Systems
A. O. Chubaryan	Corresponding member of RAN and director of RAN's Institute of General History
Yu. V. Yaremenko	RAN academician and director of RAN's Institute of National Economic Forecasting

Appendix E

1995 PLAN OF MEASURES FOR CARRYING OUT STATE SUPPORT FOR SCIENCE AND S&T DEVELOPMENTS

Measures	Time Period	Participants
I. Scientific-Technical Policy		
Doctrine for developing Russian science	2nd quarter	Ministry of Science Russian Academy of Sciences (RAN) Russian Academy of Medical Sciences (RAMN) Russian Academy of Agricultural Sciences (RASN) State Committee on Higher Education (GOSKOMVUZ) Ministry of Economics Interested ministries and departments
Proposal for priority S&T directions, list of federal-level critical technologies	3rd quarter	MinSci, MinEcon RAN, RAMN RASN, GOSKOMVUZ State Committee for Industry (GOSKOMPROM) State Committee for the Defense Industry (GKOOP) Interested ministries and departments
Proposal on organizing cooperation between ministries and departments in utilizing dual-use technologies	2nd quarter	GKOOP, GOSKOMPROM MinEcon, MinSci RAN, RAMN, RASN Ministry of Atomic Energy (MinAtom) Russian Space Agency (RKA) Ministry of Defense

SOURCE: *Poisk*, No. 19 (313), April 22–28, 1995.

Measures	Time Period	Participants
II. Formation of a Normative Legal Base		
Drafts of normative acts regulating the legal status of RAN and branch academies of sciences	3rd quarter	RAN, branch academies of sciences State Committee on Property MinSci, MinEcon Ministry of Finance Ministry of Law
Drafts of normative acts regulating the status and activity of scientific organizations and defining a system for conferring privileges and benefits on forms of scientific activity	Throughout the year	MinSci, RAN, branch academies of sciences, GOSKOMVUZ, MinFin Ministry of Labor Ministry of Law Interested ministries and departments
Draft of a normative act regulating innovative activity in the RF	3rd quarter	MinSci, MinEcon GOSKOMPROM, GKOOP RAN, branch academies of science, GOSKOMVUZ Ministry of Law
III. Financing and Economic Stimulation		
Proposal on step-by-step introduction of return-financing of applied developments which were budget-financed	July	MinSci, MinFin Bank of Russia GOSKOMPROM, GKOOP
RF government draft proposal on organizing the introduction of a federal contract system for financing S&T projects, using both budget and nonbudgetary funds	2nd quarter	MinSci, MinEcon MinFin, GOSKOMPROM RAN, RAMN, RASN GOSKOMVUZ State Committee on the Agriculture Industry GKOOP, Ministry of Law
Draft project for development and government support of innovative entrepreneurship in the RF	3rd quarter	MinSci, MinEcon GOSKOMPROM, GKOOP RAN, RASN GOSKOMVUZ, MinFin Interested ministries and departments
Drafts of normative acts on introducing changes and additions to tax and customs legislation and additional measures for economic stimulation of S&T and innovative activity	June	MinSci, MinFin MinEcon, Ministry of Foreign Economic Relations RAN, RAMN, RASN Ministry of Law Interested ministries and departments

Measures	Time Period	Participants
IV. Social Support		
Proposal for developing a mechanism for determining the size of scientific stipends for outstanding Russian scholars and talented young scholars	April	RAN, RAMN, RASN MinSci, Ministry of Labor MinFin, GOSKOMVUZ
Proposal for creating a pay system for highly qualified scientists and S&T specialists	2nd quarter	MinSci, RAN, RAMN RASN, MinFin Ministry of Labor Interested ministries and departments
V. Cooperation with the Regions		
Draft program for development and government support of scientific cities in the RF, including academic science cities, from 1995–1997	June	MinSci, MinEcon, RAN RAMN, RASN, MinAtom GKOOP
Proposals (recommendations) for a system by which RF subjects create regional nonbudget funds for S&T development	2nd quarter	MinSci, MinFin, MinEcon Interested ministries and departments

PROSPECTS FOR RUSSIAN MILITARY R&D

Given Russia's deep political, social, economic, and philosophical divisions, this is the scenario that appears most likely . . . Without strong, directed leadership, socioeconomic distress will persist and science will remain a "top national priority" in name alone . . . continuation of the status quo will mean a serious degradation of basic experimental scientific capability within the next two years, a loss which will have a negative effect on basic theoretical, applied, and defense science as well.

Sharon Leiter, Prospects for Russian Military R&D

Revelations emerging from the war in Chechnya on the shoddy state of Russian weaponry and military equipment have shocked the public. This study reports how drastic military downsizing and defense budget cuts have undermined weapons research and production. Cuts are being felt most keenly in the Russian science and technical research community, where massive firings and the disintegration of institutes and laboratories are predicted.

The author examines the prospects for the revitalization of the once-powerful Russian military research and development sector. The Russian military's ability to modernize its weapons and develop new ones will have to rely on either a revitalized state military R&D sector or a robust civil scientific and technical sector. Is it possible that neither of these sectors is likely to prove adequate to the military's needs in the near term, forcing Russia to turn to the West or elsewhere for military-technical assistance? The author investigates trends in the Russian scientific community as a whole, including science funding, higher education, the brain drain, and the evolution of scientific organizations.

This report should be of interest to members of the U.S. intelligence and policy communities, the international scientific community, and others concerned with Russia's role both as a military power and as a supplier of weaponry on the world market.

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